

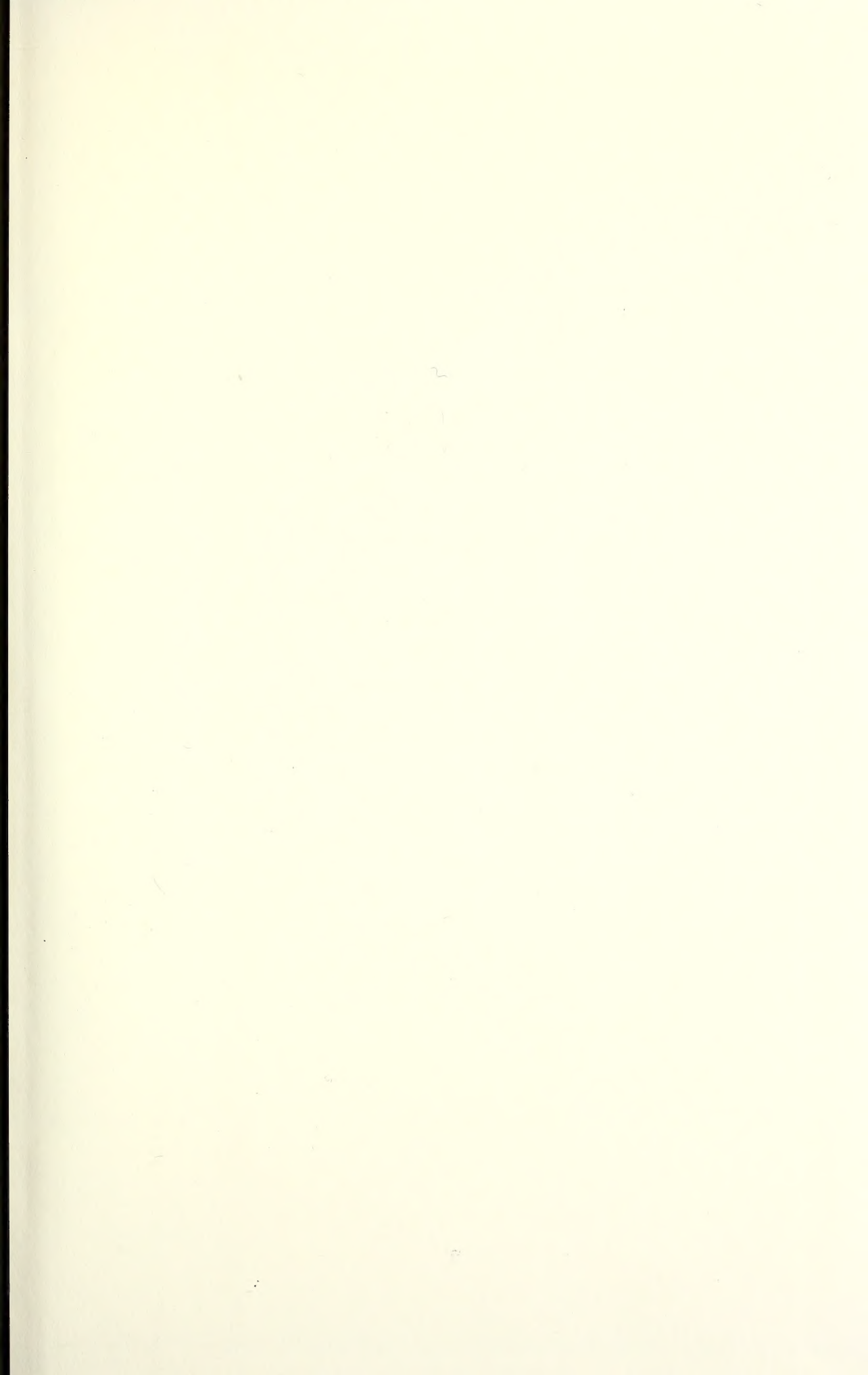




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1981-1983

# The Pennsylvania State University Bulletin

## Graduate Degree Programs

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**1981-1983**

# **THE PENNSYLVANIA STATE UNIVERSITY**

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## **GRADUATE DEGREE PROGRAMS**

**GENERAL CATALOG  
SEPTEMBER 1981**

### **IMPORTANT NOTICE**

Early in 1981 The Pennsylvania State University began planning to change from an academic year consisting of four 10-week terms to an academic year consisting of two semesters and an 8-week summer session. This change will occur with the academic year beginning in the fall of 1983.

One consequence of the change is that this graduate bulletin has been published to cover a period of two years, encompassing the last academic sessions under the term system (fall 1981 through summer 1983).

Information on important changes in programs, regulations, procedures, or requirements of the Graduate School that occur under the term system but subsequent to the publication of this bulletin will accompany copies of this bulletin, beginning in the fall of 1982.

A new bulletin for use under the semester system will be issued in the spring term of 1983.

Address inquiries regarding the Graduate School to:

Graduate School Information Center

The Pennsylvania State University

113 Kern Graduate Building

University Park, PA 16802

Telephone: Area Code 814-865-5436



# ADMINISTRATIVE CENTERS OF THE GRADUATE SCHOOL

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The Pennsylvania State University  
500 University Drive  
Hershey, PA 17033  
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## THE PENNSYLVANIA STATE UNIVERSITY BULLETIN (USPS 426-680)

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## REGULATIONS SUBJECT TO CHANGE

The educational process necessitates change. This bulletin must be considered as informational and not binding on the University.

Each step of the educational process, from admission through graduation, requires continuing review and appropriate approval by University officials. The University, therefore, reserves the right to change the requirements and regulations contained in this bulletin and to determine whether a student has satisfactorily met its requirements for admission or graduation, and to reject any applicant for admission for any reason the University determines to be material to the applicant's qualification to pursue higher education. Nothing in this bulletin should be considered a guarantee that completion of a program and graduation from the University will result in employment.

The Pennsylvania State University, in compliance with federal and state laws and regulations governing affirmative action and nondiscrimination, does not discriminate in the recruitment, admission, and employment of students, faculty, and staff in the operation of any of its educational programs and activities as defined by law. Accordingly, nothing in this publication should be viewed as directly or indirectly expressing any limitation, specification, or discrimination as to race, religion, color, or national origin; or to handicap, age, sex, or status as a disabled or Vietnam-era veteran, except as provided by law. Inquiries concerning this policy may be directed to the vice president for student affairs.

# GRADUATE CALENDAR\*

## FALL TERM 1981

### AUGUST 1981

- 3 Monday — Last date for a prospective graduate student to submit completed application materials for admission to the fall term 1981
- 3 Monday — Last date for a graduate student to apply for permission to resume study in the fall term 1981

### SEPTEMBER

- 3, 4 Thursday, Friday — Fall term registration
- 7 Monday — Labor Day holiday
- 8 Tuesday — Fall term classes begin 8:00 A.M.
- 18 Friday — Last date for applying for Graduate School tuition grant-in-aid for winter term 1982
- 21 Monday — Last date for a November graduate to pay thesis fee at Bursar's Office *and* to activate diploma card in Records Office

### OCTOBER

- 3 Saturday — Last date for a November graduate to deliver doctoral thesis to committee
- 10 Saturday — Last date for final oral doctoral examinations for November graduates
- 10 Saturday — Last date for a November graduate to deliver master's thesis or paper to adviser
- 12 Monday — Last date for a November graduate to submit camera-ready thesis manuscript to Thesis Office
- 26 Monday — Last date for a November graduate to deliver thesis to Graduate School
- 26 Monday — Last date for departments to certify to Graduate School completion of required papers for November graduates
- 26 Monday — Date for a November graduate to order cap, gown, and hood locally

### NOVEMBER

- 13 Friday — Last date for submitting a petition to the Records Office to graduate *in absentia* in November
- 16 Monday — Fall term classes end 9:55 P.M.
- 17-20 Tuesday to Friday — Final examinations
- 26 Thursday — Thanksgiving Day holiday
- 28 Saturday — Commencement

\*This calendar is subject to change without notice. In preparing the calendar for an academic year, the University makes every effort to avoid conflicts with religious holidays. However, such conflicts are sometimes unavoidable. When they occur, efforts are made to make special arrangements for the students affected.

NOTE: Students who plan to take examinations in French and Spanish should apply through the Office of Graduate Programs, 211 Kern Graduate Building. Times and places of tests will be announced when the application is filed.



## WINTER TERM 1982

### NOVEMBER 1981

- 2 Monday — Last date for a prospective graduate student to submit completed application materials for admission to the winter term 1982
- 2 Monday — Last date for a graduate student to apply for permission to resume study in the winter term 1982

### DECEMBER

- 1, 2 Tuesday, Wednesday — Winter term registration
- 3 Thursday — Winter term classes begin 8:00 A.M.
- 16 Wednesday — Last date for a March graduate to pay thesis fee at Bursar's Office *and* to activate diploma card in Records Office
- 19 Saturday — Winter term recess begins 12:25 P.M.

### JANUARY 1982

- 4 Monday — Winter term classes resume 8:00 A.M.
- 5 Tuesday — Deadline for applying for Graduate School tuition grant-in-aid for spring term 1982
- 9 Saturday — Last date for a March graduate to deliver doctoral thesis to committee
- 16 Saturday — Last date for final oral doctoral examinations for March graduates
- 16 Saturday — Last date for a March graduate to deliver master's thesis or paper to adviser
- 18 Monday — Last date for a March graduate to submit camera-ready thesis manuscript to Thesis Office

### FEBRUARY

- 1 Monday — Last date for a March graduate to deliver thesis to Graduate School
- 1 Monday — Last date for departments to certify to Graduate School completion of required papers for March graduates
- 1 Monday — Deadline for Penn State graduate students to apply for fellowships and traineeships awarded by the Graduate School
- 15 Monday — Deadline for incoming graduate students to apply for fellowships and traineeships awarded by the Graduate School
- 19 Friday — Last date for submitting a petition to the Records Office to graduate *in absentia* in March
- 24 Wednesday — Winter term classes end 9:55 P.M.
- 25-27 Thursday to Saturday — Final examinations

### MARCH

- 1 Monday — Final examinations
- 6 Saturday — Commencement

NOTE: Students who plan to take examinations in French and Spanish should apply through the Office of Graduate Programs, 211 Kern Graduate Building. Times and places of tests will be announced when the application is filed.

## SPRING TERM 1982

### FEBRUARY 1982

- 9 Tuesday — Last date for a prospective graduate student to submit completed application materials for admission to the spring term 1982
- 9 Tuesday — Last date for a graduate student to apply for permission to resume study in the spring term 1982

### MARCH

- 9, 10 Tuesday, Wednesday — Spring term registration
- 11 Thursday — Spring term classes begin 8:00 A.M.
- 24 Wednesday — Last date for a May graduate to pay thesis fee at Bursar's Office *and* to activate diploma card in Records Office

### APRIL

- 2 Friday — Deadline for applying for Graduate School tuition grant-in-aid for summer and fall term 1982
- 3 Saturday — Last date for a May graduate to deliver doctoral thesis to committee
- 10 Saturday — Last date for final oral doctoral examinations for May graduates
- 10 Saturday — Last date for a May graduate to deliver master's thesis or paper to adviser
- 12 Monday — Last date for a May graduate to submit camera-ready thesis manuscript to Thesis Office
- 26 Monday — Last date for a May graduate to deliver thesis to Graduate School
- 26 Monday — Last date for departments to certify to Graduate School completion of required papers for May graduates

### MAY

- 14 Friday — Last date for submitting a petition to the Records Office to graduate *in absentia* in May
- 19 Wednesday — Spring term classes end 9:55 P.M.
- 20-22 Thursday to Saturday — Final examinations
- 24 Monday — Final examinations
- 29 Saturday — Commencement

## SUMMER TERM 1982

### MAY 1982

- 10 Monday — Last date for a prospective graduate student to submit completed application materials for admission to the summer term 1982
- 10 Monday — Last date for a graduate student to apply for permission to resume study in the summer term 1982

### JUNE

- 8 Tuesday — Summer term registration
- 9 Wednesday — Summer term classes begin 8:00 A.M.
- 21 Monday — Last date for an August graduate to pay thesis fee at Bursar's Office *and* to activate diploma card in Records Office

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NOTE: Students who plan to take examinations in French and Spanish should apply through the Office of Graduate Programs, 211 Kern Graduate Building. Times and places of tests will be announced when the application is filed.



## JULY

- 3 Saturday — Last date for an August graduate to deliver doctoral thesis to committee
- 4 Sunday — Independence Day holiday
- 5 Monday — Independence Day observed (no classes)
- 10 Saturday — Last date for final oral doctoral examinations for August graduates
- 10 Saturday — Last date for an August graduate to deliver master's thesis or paper to adviser
- 12 Monday — Last date for an August graduate to submit camera-ready thesis manuscript to Thesis Office
- 26 Monday — Last date for an August graduate to deliver thesis to Graduate School
- 26 Monday — Last date for departments to certify to Graduate School completion of required papers for August graduates

## AUGUST

- 13 Friday — Last date for submitting a petition to the Records Office to graduate *in absentia* in August
- 18 Wednesday — Summer term classes end 9:55 P.M.
- 19-21 Thursday to Saturday — Final examinations
- 28 Saturday — Commencement

## FALL TERM 1982

### AUGUST 1982

- 2 Monday — Last date for a prospective graduate student to submit completed application materials for admission to the fall term 1982
- 2 Monday — Last date for a graduate student to apply for permission to resume study in the fall term 1982

### SEPTEMBER

- 1-3 Wednesday noon to Friday — Fall term registration
- 6 Monday — Labor Day holiday
- 7 Tuesday — Fall term classes begin 8:00 A.M.
- 17 Friday — Last date for applying for Graduate School tuition grant-in-aid for winter term 1983
- 20 Monday — Last date for a November graduate to pay thesis fee at Bursar's Office *and* to activate diploma card in Records Office

### OCTOBER

- 2 Saturday — Last date for a November graduate to deliver doctoral thesis to committee
- 9 Saturday — Last date for final oral doctoral examinations for November graduates
- 9 Saturday — Last date for a November graduate to deliver master's thesis or paper to adviser
- 11 Monday — Last date for a November graduate to submit camera-ready thesis manuscript to Thesis Office
- 25 Monday — Last date for a November graduate to deliver thesis to Graduate School
- 25 Monday — Last date for departments to certify to Graduate School completion of required papers for November graduates

NOTE: Students who plan to take examinations in French and Spanish should apply through the Office of Graduate Programs, 211 Kern Graduate Building. Times and places of tests will be announced when the application is filed.

## NOVEMBER

- 12 Friday — Last date for submitting a petition to the Records Office to graduate *in absentia* in November
- 15 Monday — Fall term classes end 9:55 P.M.
- 16-20 Tuesday to Saturday — Final examinations
- 25 Thursday — Thanksgiving Day holiday
- 27 Saturday — Commencement

## WINTER TERM 1983

### NOVEMBER 1982

- 1 Monday — Last date for a prospective graduate student to submit completed application materials for admission to the winter term 1983
- 1 Monday — Last date for a graduate student to apply for permission to resume study in the winter term 1983
- 30 Tuesday — Winter term registration

### DECEMBER

- 1 Wednesday — Winter term registration
- 2 Thursday — Winter term classes begin 8:00 A.M.
- 13 Monday — Last date for a March graduate to pay thesis fee at Bursar's Office *and* to activate diploma card in Registrar's Office
- 21 Tuesday — Winter term recess begins 9:55 P.M.

### JANUARY 1983

- 3 Monday — Winter term classes resume 8:00 A.M.
- 4 Tuesday — Last date for applying for Graduate School tuition grants-in-aid for the spring term 1983
- 8 Saturday — Last date for a March graduate to deliver doctoral thesis to committee
- 15 Saturday — Last date for final oral doctoral examinations for March graduates
- 15 Saturday — Last date for a March graduate to deliver master's thesis or paper to adviser
- 17 Monday — Last date for a March graduate to submit camera-ready thesis manuscript to Thesis Office
- 31 Monday — Last date for a March graduate to deliver thesis to Graduate School
- 31 Monday — Last date for departments to certify to Graduate School completion of required papers for March graduates

### FEBRUARY

- 1 Tuesday — Deadline for Penn State graduate students to apply for fellowships and traineeships awarded by the Graduate School
- 15 Tuesday — Deadline for incoming graduate students to apply for fellowships and traineeships awarded by the Graduate School
- 18 Friday — Last date for submitting a petition to the Records Office to graduate *in absentia* in March

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NOTE: Students who plan to take examinations in French and Spanish should apply through the Office of Graduate Programs, 211 Kern Graduate Building. Times and places of tests will be announced when the application is filed.



- 21 Monday — Winter term classes end 9:55 P.M.
- 22-25 Tuesday to Friday — Final examinations

## MARCH

- 5 Saturday — Commencement

## SPRING TERM 1983

### FEBRUARY 1983

- 8 Tuesday — Last date for a prospective graduate student to submit completed application materials for admission to the spring term 1983
- 8 Tuesday — Last date for a graduate student to apply for permission to resume study in the spring term 1983

### MARCH

- 8,9 Tuesday, Wednesday — Spring term registration
- 10 Thursday — Spring term classes begin 8:00 A.M.
- 21 Monday — Last date for a May graduate to pay thesis fee at Bursar's Office *and* to activate diploma card in Registrar's Office

### APRIL

- 2 Saturday — Last date for a May graduate to deliver doctoral thesis to committee
- 4 Monday — Last date for applying for Graduate School tuition grants-in-aid for summer term 1983 and fall semester 1983
- 9 Saturday — Last date for final oral doctoral examinations for May graduates
- 9 Saturday — Last date for a May graduate to deliver master's thesis or paper to adviser
- 11 Monday — Last date for a May graduate to submit camera-ready thesis manuscript to Thesis Office
- 25 Monday — Last date for a May graduate to deliver thesis to Graduate School
- 25 Monday — Last date for departments to certify to Graduate School completion of required papers for May graduates

### MAY

- 13 Friday — Last date for submitting a petition to the Records Office to graduate *in absentia* in May
- 18 Wednesday — Spring term classes end 9:55 P.M.
- 19-21 Thursday to Saturday — Final examinations
- 23 Monday — Final examinations
- 28 Saturday — Commencement

NOTE: Students who plan to take examinations in French and Spanish should apply through the Office of Graduate Programs, 211 Kern Graduate Building. Times and places of tests will be announced when the application is filed.

## SUMMER TERM 1983

### MAY 1983

- 9 Monday — Last date for a prospective graduate student to submit completed application materials for admission to the summer term 1983
- 9 Monday — Last date for a graduate student to apply for permission to resume study in the summer term 1983

### JUNE

- 7 Tuesday — Summer term registration
- 8 Wednesday — Summer term classes begin 8:00 A.M.
- 20 Monday — Last date for an August graduate to pay thesis fee at Bursar's Office *and* to activate diploma card in Registrar's Office

### JULY

- 2 Saturday — Last date for an August graduate to deliver doctoral thesis to committee
- 4 Monday — Independence Day holiday
- 9 Saturday — Last date for final oral doctoral examinations for August graduates
- 9 Saturday — Last date for an August graduate to deliver master's thesis or paper to adviser
- 11 Monday — Last date for an August graduate to submit camera-ready thesis manuscript to Thesis Office
- 25 Monday — Last date for an August graduate to deliver thesis to Graduate School Office
- 25 Monday — Last date for departments to certify to Graduate School completion of required papers for August graduates

### AUGUST

- 12 Friday — Last date for submitting a petition to the Records Office to graduate *in absentia* in August
- 17 Wednesday — Summer term classes end 9:55 P.M.
- 18-20 Thursday to Saturday — Final examinations
- 27 Saturday — Commencement

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NOTE: Students who plan to take examinations in French and Spanish should apply through the Office of Graduate Programs, 211 Kern Graduate Building. Times and places of tests will be announced when the application is filed.



# ADMINISTRATION 1981-1983

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COMMITTEE ON PROGRAMS AND COURSES

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COMMITTEE ON FELLOWSHIPS AND AWARDS  
COMMITTEE ON GRADUATE COMMONS AND RELATED MATTERS  
COMMITTEE ON LECTURE SERIES



# GRADUATE FACULTY 1981-1983\*

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 ALBERT A. ANDERSON, Ph.D. (Ohio State) *Associate Professor of Art Education*  
 ARTHUR ANDERSON, Jr., M.F.A. (Princeton) *Associate Professor of Architecture*  
 DAVID A. ANDERSON, Ph.D. (Purdue) *Associate Professor of Civil Engineering*  
 ELIZABETH P. ANDERSON, Ph.D. (Minnesota) *Assistant Professor of Human Development*  
 JAMES B. ANDERSON, Ph.D. (Princeton) *Professor of Chemistry*  
 JOEL H. ANDERSON, Ph.D. (Indiana) *Associate Professor of Mathematics*  
 GEORGE E. ANDREWS, Ph.D. (Pennsylvania) *Professor of Mathematics*  
 RICHARD A. ANTHES, Ph.D. (Wisconsin) *Professor of Meteorology*  
 ADAM ANTHONY, Ph.D. (Chicago) *Professor of Zoology*  
 CHARLES E. ANTLE, Ph.D. (Oklahoma State) *Professor of Statistics*  
 FRANK F. APLAN, Sc.D. (M.I.T.) *Professor of Metallurgy and Mineral Processing*  
 ROBERT ARIEW, Ph.D. (Illinois) *Assistant Professor of French*  
 STEVE ARMENTROUT, Ph.D. (Texas) *Professor of Mathematics*  
 DEAN E. ARNOLD, Ph.D. (Cornell) *Assistant Professor of Biology*  
 JUDD B. ARNOLD, Ph.D. (Connecticut) *Associate Professor of English*  
 STEVEN F. ARNOLD, Ph.D. (Stanford) *Assistant Professor of Statistics*  
 GERT ARON, Ph.D. (California), P.E. *Associate Professor of Civil Engineering*  
 NATHAN N. ARONSON, Jr., Ph.D. (Duke) *Associate Professor of Biochemistry*  
 RICHARD N. ARTECA, Ph.D. (Washington State) *Assistant Professor of Olericulture*  
 S. ASHOK, Ph.D. (Rensselaer Polytech.) *Assistant Professor of Engineering Science*  
 EUNICE N. ASKOV, Ph.D. (Wisconsin) *Professor of Education*  
 VERNON H. ASPATURIAN, Ph.D. (U.C.L.A.) *Evan Pugh Professor of Political Science*  
 LAWRENCE H. AUER, Ph.D. (Princeton) *Associate Professor of Astronomy*

\*Printer deadlines prohibit changes in the Graduate Faculty listings under graduate major programs after March 1, 1981.

DEBORAH S. AUSTIN, Ph.D. (Bryn Mawr) *Professor of English*  
 LEONARD G. AUSTIN, Ph.D. (Penn State) *Professor of Fuels and Mineral Engineering*  
 ROY L. AUSTIN, Ph.D. (Washington) *Assistant Professor of Sociology*  
 PAUL AXT, Ph.D. (Wisconsin) *Professor of Mathematics*  
 JOHN E. AYERS, Ph.D. (Penn State) *Professor of Plant Pathology*  
 CHRISTINE W. AYOUB, Ph.D. (Yale) *Professor of Mathematics*  
 RAYMOND G. D. AYOUB, Ph.D. (Illinois) *Professor of Mathematics*  
 WILLEM ADRIANUS BAAN, Ph.D. (M.I.T.) *Assistant Professor of Astronomy*  
 CLIFTON A. BAILE, Ph.D. (Missouri) *Adjunct Associate Professor of Animal Nutrition*  
 IRWIN L. BAIRD, Ph.D. (Harvard) *Professor of Anatomy*  
 ROBERT W. BAISLEY, M.A. (Columbia) *Professor of Music*  
 DALE E. BAKER, Ph.D. (Missouri) *Professor of Soil Chemistry*  
 PAUL T. BAKER, Ph.D. (Harvard) *Professor of Anthropology*  
 STANLEY B. BAKER, Ph.D. (S.U.N.Y.) *Associate Professor of Education*  
 WALTER L. BAKER, M.S. (Penn State), P.E. *Professor of Engineering Research*  
 JOHN BALABAN, A.M. (Harvard) *Associate Professor of English*  
 PHILIP H. BALDI, Ph.D. (Rochester) *Associate Professor of Linguistics*  
 ROBERT C. BALDWIN, Ph.D. (Penn State) *Asst. Professor of Wood Science and Technology*  
 ANTHONY J. BARATTA, Ph.D. (Brown) *Assistant Professor of Nuclear Engineering*  
 HUBERT L. BARNES, Ph.D. (Columbia) *Professor of Geochemistry*  
 STEVEN M. BARNES, Ph.D. (Michigan State) *Assistant Professor of Education*  
 ROBERT M. BARNOFF, Ph.D. (Carnegie Tech.), P.E. *Professor of Civil Engineering*  
 GERHARD R. BARSCH, Dr.rer.nat. (Göttingen) *Professor of Physics*  
 GERALD L. BARTLETT, Ph.D. (Pennsylvania) *Associate Professor of Pathology and Microbiology*  
 MICHAEL L. BARTON, Ph.D. (Pennsylvania) *Associate Professor of Social Science*  
 PAUL BARTON, Ph.D. (Penn State), P.E. *Assistant Professor of Chemical Engineering*  
 RICHARD L. BARTON, Ph.D. (Oregon) *Associate Professor of Speech Communication*  
 JAMES B. BARTOO, Ph.D. (Iowa) *Professor of Mathematical Statistics*  
 EUGENIO BATTISTI, Perfezionamento (Rome) *Evan Pugh Professor of Art History*  
 JOHN E. BAYLOR, Ph.D. (Penn State) *Professor of Agronomy Extension*  
 ROBERT C. BEALER, Ph.D. (Michigan State) *Professor of Rural Sociology*  
 ROBERT M. BEAR, Ph.D. (Iowa) *Associate Professor of Finance*  
 DAVID J. BEATTIE, Ph.D. (Michigan State) *Assistant Professor of Ornamental Horticulture*  
 PHILIP M. BECKER, Ph.D. (Minnesota) *Assistant Professor of Fuel Science*  
 ROBERT BEELMAN, Ph.D. (Ohio State) *Associate Professor of Food Science*  
 MICHAEL H. BEGNAL, Ph.D. (Washington) *Professor of English and Comparative Literature*  
 JAMES G. BEIERLEIN, Ph.D. (Purdue) *Asst. Prof. of Agricultural Economics*  
 LELAND L. BEIK, Ph.D. (Columbia) *Professor of Marketing*  
 KENNETH R. BEITTEL, D.Ed. (Penn State) *Professor of Art Education*  
 PAUL E. BELL, D.Ed. (Oregon) *Associate Professor of Education*  
 EDWARD D. BELLIS, Ph.D. (Minnesota) *Professor of Biology*  
 JAY BELSKY, Ph.D. (Cornell) *Assistant Professor of Human Development*  
 STEPHEN J. BENKOVIC, Ph.D. (Cornell) *Evan Pugh Professor of Chemistry*  
 PETER D. BENNETT, Ph.D. (Texas) *Professor of Marketing*  
 JAMES D. BENSHOOF, M.A. (Penn State) *Assistant Professor of Music*  
 BRUCE L. BENSON, Ph.D. (Texas A & M) *Assistant Professor of Economics*  
 THOMAS W. BENSON, Ph.D. (Cornell) *Professor of Speech Communication*  
 ALLEN W. BENTON, Ph.D. (Cornell) *Professor of Entomology*  
 CLYDE C. BERG, Ph.D. (Washington State) *Adjunct Assistant Professor of Agronomy*  
 ERNEST L. BERGMAN, Ph.D. (Michigan State) *Professor of Plant Nutrition*  
 ASA J. BERLIN, Ph.D. (Northwestern) *Professor of Speech Pathology*  
 CHESTON M. BERLIN, M.D. (Harvard) *Professor of Pediatrics and Pharmacology*  
 R. THOMAS BERNER, M.A. (Penn State) *Assistant Professor of Journalism*  
 ROBERT A. BERNHEIM, Ph.D. (Illinois) *Professor of Chemistry*  
 ROBERT W. BERNLOHR, Ph.D. (Ohio State) *Professor of Biochemistry*  
 JOHN H. BEST, Ph.D. (North Carolina) *Professor of Education*



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 VEERASINGHAM P. BHAVANANDAN, Ph.D. (Edinburgh) *Assoc. Professor of Biological Chemistry*  
 Z. T. BIENIAWSKI, D.Sc. (Pretoria) *Professor of Mineral Engineering*  
 GORDON R. BIENVENUE, Ph.D. (Penn State) *Research Associate in Audiology*  
 JAMES V. BIGGERS, Ph.D. (Penn State) *Sr. Res. Associate at Materials Research Laboratory*  
 WILLIAM E. BILES, Ph.D. (Virginia Polytechnic) *Professor of Industrial Engineering*  
 MICHAEL L. BILLET, Ph.D. (Penn State) *Research Associate at Applied Research Laboratory*  
 SIGMUND S. BIRKENMAYER, Ph.D. (Wisconsin) *Professor of Slavic Languages*  
 BARNARD H. BISSINGER, Ph.D. (Cornell) *Professor of Mathematics*  
 STEWART W. BITHER, D.B.A. (Washington) *Professor of Marketing*  
 WILLIAM R. BITLER, Ph.D. (Carnegie Tech.) *Professor of Metallurgy*  
 EDWARD O. BIXLER, Ph.D. (New Mexico) *Associate Professor of Psychiatry*  
 ALFRED K. BLACKADAR, Ph.D. (New York) *Professor of Meteorology*  
 DOROTHY BLAIR, Ph.D. (Cornell) *Associate Professor of Nutrition*  
 ROBERT O. BLANCHARD, Ph.D. (Syracuse) *Professor of Journalism*  
 PAUL R. BLANKENHORN, Ph.D. (Penn State) *Assistant Professor of Wood Technology*  
 BARBARA L. BLEAU, Ph.D. (Penn State) *Assistant Professor of Mathematics*  
 JAMES G. BLENCOE, Ph.D. (Stanford) *Assistant Professor of Geochemistry*  
 ERNST BLEULER, D.Sc.Nat. (Zürich), habil. *Professor of Physics*  
 EMERY P. BLIESMER, Ph.D. (Iowa State) *Professor of Education*  
 JAMES R. BLOOM, Ph.D. (Wisconsin) *Professor of Plant Pathology*  
 ALLEN C. BLUEDORN, Ph.D. (Iowa) *Assistant Professor of Organizational Behavior*  
 WILLIAM M. BODE, Ph.D. (Ohio State) *Assistant Professor of Entomology*  
 CRAIG F. BOHREN, Ph.D. (Arizona) *Assistant Professor of Meteorology*  
 JEAN-HUGUES A. BOISSET, Ph.D. (Florida) *Assistant Professor of French*  
 JEAN-MARC BOLLAG, Ph.D. (Basel) *Professor of Soil Microbiology*  
 RICHARD C. BOLLINGER, Ph.D. (Pittsburgh) *Associate Professor of Mathematics*  
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 ALFRED L. BORTREE, D.V.M. (Michigan State) *Professor of Veterinary Science*  
 EUGENE N. BORZA, Ph.D. (Chicago) *Associate Professor of History*  
 TODD W. BOWERSOX, Ph.D. (Penn State) *Assistant Professor of Silviculture*  
 WILLIAM L. BOYD, Ph.D. (Chicago) *Professor of Education*  
 J. DAVID BOYLE, Ph.D. (Kansas) *Professor of Music Education*  
 JOHN S. BOYLE, Ph.D. (Wisconsin) *Professor of Plant Pathology*  
 JOSEPH F. BRADLEY, Ph.D. (Pittsburgh) *Professor of Finance*  
 WILLIAM R. BRADLEY, Ph.D. (Minnesota) *Associate Professor of Art Education*  
 RICHARD C. BRADT, Ph.D. (Rensselaer Polytech.) *Professor of Ceramic Science*  
 JEANNETTE DANIELLE BRAGGER, Ph.D. (California) *Assistant Professor of French*  
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 ROBERT W. BRENNAN, M.D. (Cornell) *Professor of Medicine*  
 ROBERT J. BRESLER, Ph.D. (Princeton) *Assoc. Prof. of Social Science and Political Science*  
 DAVID MARIUS BRESSOUD, Ph.D. (Temple) *Assistant Professor of Mathematics*  
 JEAN O. BRITTON, Ph.D. (Chicago) *Professor of Education and Psychology*  
 JOSEPH H. BRITTON, Ph.D. (Chicago) *Professor of Human Development*  
 DAVID J. BROWN, Ph.D. (Ohio State) *Affiliate Assistant Professor of Psychology*  
 EMORY J. BROWN, Ph.D. (Michigan State) *Professor of Rural Sociology*  
 FREDERICK M. BROWN, Ph.D. (Virginia) *Assoc. Professor of Psychology*  
 IRA V. BROWN, Ph.D. (Harvard) *Professor of American History*  
 J. CUDD BROWN, Ph.D. (Oregon) *Professor of Political Science*  
 JOHN L. BROWN, Jr., Ph.D. (Brown) *Professor of Electrical Engineering*  
 RAYMOND H. BROWN, B.S. (Johns Hopkins) *Professor of Music*  
 ROBERT J. BROWN, Ph.D. (New York) *Associate Professor of Finance*  
 TERENCE A. BROWN, D.B.A. (Maryland) *Associate Professor of Business Logistics*

WOODROW D. BROWNAWELL, Ph.D. (Cornell) *Professor of Mathematics*  
 BARTON W. BROWNING, Ph.D. (California) *Associate Professor of German*  
 ROBERT S. BRUBAKER, Ph.D. (Illinois) *Professor of Speech Communication*  
 JOHN D. C. BUCK, Ph.D. (California) *Assistant Professor of English*  
 ROY C. BUCK, Ph.D. (Minnesota) *Professor of Sociology and Social Science*  
 RONALD E. BUCKALEW, Ph.D. (Illinois) *Associate Professor of English*  
 EDWARD C. BUDD, Ph.D. (California) *Professor of Economics*  
 JOE P. BUHLER, Ph.D. (Harvard) *Assistant Professor of Mathematics*  
 BRUCE BULLINGTON, Ph.D. (California) *Associate Professor of the Administration of Justice*  
 LESLIE P. BULLOCK, D.V.M. (California) *Associate Professor of Comparative Medicine*  
 LESTER A. BURDETTE, Ph.D. (Penn State) *Professor of Animal Science Extension*  
 ROBERT L. BURGESS, Ph.D. (Washington, St. Louis) *Professor of Human Development*  
 C. WAYNE BURNHAM, Ph.D. (California Tech.) *Professor of Geochemistry*  
 LANDON C. BURNS, Ph.D. (Yale) *Professor of English*  
 JOHN E. BURRIS, Ph.D. (California) *Assistant Professor of Biology*  
 ELI D. BUSKIRK, JR., Ph.D. (Michigan) *Assistant Professor of Regional Planning*  
 ELSWORTH R. BUSKIRK, Ph.D. (Minnesota) *Professor of Applied Physiology*  
 EDWARD G. BUSS, Ph.D. (Purdue) *Professor of Poultry Science*  
 ROBERT L. BUTLER, Ph.D. (Minnesota) *Professor of Biology*  
 DAVID E. BUTT, D.Ed. (Penn State) *Associate Professor of Speech Communication*  
 ROBERT L. BUTTERWORTH, Ph.D. (California) *Associate Professor of Political Science*  
 ROBERT A. BYERS, Ph.D. (Purdue) *Adjunct Associate Professor of Entomology*  
 CAROL BYRD-BREDBENNER, Ph.D. (Penn State) *Assistant Professor of Nutrition*  
 PHILIP D. CADY, Ph.D. (Penn State), P.E. *Professor of Civil Engineering*  
 JOHN J. CAHIR, Ph.D. (Penn State) *Professor of Meteorology*  
 STEPHEN N. CALCULATOR, Ph.D. (Wisconsin) *Assistant Professor of Communication Disorders*  
 WILLIAM E. CALDWELL, Ph.D. (New York) *Associate Professor of Education*  
 THOMAS M. CALLAGHY, Ph.D. (California) *Assistant Professor of Political Science*  
 E. ALAN CAMERON, Ph.D. (California) *Associate Professor of Entomology*  
 C. SEYMOUR CARD, Ph.D. (Colorado State) *Professor of Veterinary Science*  
 TOBY N. CARLSON, Ph.D. (Imperial, London) *Associate Professor of Meteorology*  
 LYNN A. CARPENTER, Ph.D. (Illinois) *Associate Professor of Electrical Engineering*  
 MAUREEN A. CARR, Ph.D. (Wisconsin) *Professor of Music*  
 JOSEPH L. CARROLL, D.B.A. (Indiana) *Professor of Business Administration*  
 ROBERT W. CARRUBBA, Ph.D. (Princeton) *Professor of Classics*  
 CAROL A. CARTWRIGHT, Ph.D. (Pittsburgh) *Professor of Education*  
 G. PHILLIP CARTWRIGHT, Ph.D. (Pittsburgh) *Professor of Special Education*  
 ERSKINE H. CASH, Ph.D. (Michigan State) *Associate Professor of Animal Science*  
 LESTER E. CASIDA, JR., Ph.D. (Wisconsin) *Professor of Microbiology*  
 LAWRENCE CATHLES III, Ph.D. (Princeton) *Associate Professor of Geosciences*  
 PETER R. CAVANAGH, Ph.D. (Royal Free Medical) *Assoc. Professor of Biomechanics*  
 JOSEPH L. CAVINATO, Ph.D. (Penn State) *Assistant Professor of Business Logistics*  
 RICHARD P. CHAIT, Ph.D. (Wisconsin) *Affiliate Associate Professor of Education*  
 MOSES H.-W. CHAN, Ph.D. (Cornell) *Assistant Professor of Physics*  
 M. JEYA CHANDRA, Ph.D. (Syracuse) *Assistant Professor of Industrial Engineering*  
 PARRIS H. CHANG, Ph.D. (Columbia) *Professor of Political Science*  
 SALLY CHANT, Ph.D. (Michigan State) *Assistant Professor of Reading*  
 HUGH H. CHAPMAN, JR., Ph.D. (Harvard) *Professor of Romance Languages*  
 DAVID R. CHASE, Ph.D. (Texas A & M) *Assoc. Prof. of Recreation and Parks*  
 KALYAN CHATTERJEE, D.B.A. (Harvard) *Assistant Professor of Management Science*  
 GOONG CHEN, Ph.D. (Wisconsin) *Assistant Professor of Mathematics*  
 CHARLES C. CHERRY, Ph.D. (Drew) *Professor of Religious Studies*  
 RUPERT F. CHISHOLM, Ph.D. (Case Western Reserve) *Assistant Professor of Management*  
 YAR G. CHOMICKY, M.S. (Penn State) *Professor of Art Education*  
 PAROMITA CHOWLA, Ph.D. (Colorado) *Associate Professor of Mathematics*  
 PETER CHRISTENSON, Ph.D. (Stanford) *Assistant Professor of Speech Communication*



- MONTY L. CHRISTIANSEN, M.L.A. (Iowa State) *Assoc. Prof. of Landscape Architecture and Recreation and Parks*
- ROBERT W. CHRISTINA, Ph.D. (Maryland) *Professor of Physical Education*
- ETON FREDERICK CHURCHILL, M.F.A. (Tulane) *Assoc. Prof. of Humanities and Multimedia Journalism*
- STEPHEN J. CIMBALA, Ph.D. (Wisconsin) *Associate Professor of Political Science*
- EDWARD J. CIOLKOSZ, Ph.D. (Wisconsin) *Prof. of Soil Genesis and Morphology*
- JOHN THOMAS CIRN, Ph.D. (Wisconsin) *Assistant Professor of Health Planning and Administration*
- JOHN H. E. CLARK, Ph.D. (Florida State) *Associate Professor of Meteorology*
- FRANK CLEMENTE, Ph.D. (Tennessee) *Professor of Sociology*
- RICHARD W. CLEVELAND, Ph.D. (California) *Professor of Plant Breeding*
- CLIFFORD C. CLOGG, Ph.D. (Chicago) *Assistant Professor of Sociology*
- PHILIP L. COCHRAN, Ph.D. (Washington) *Assistant Professor of Business Administration*
- HERMAN COHEN, Ph.D. (Iowa) *Professor of Speech Communication*
- SIDNEY COHN, Ph.D. (North Carolina) *Professor of Man-Environment Relations*
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- MILTON W. COLE, Ph.D. (Chicago) *Associate Professor of Physics*
- RICHARD H. COLE, Ph.D. (Penn State) *Associate Professor of International Agronomy*
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- CLARENCE H. COLLISON, Ph.D. (Michigan State) *Assistant Professor of Entomology Extension*
- ROBERT W. COLMAN, Ph.D. (North Carolina) *Asst. Prof. of Soc. Science and Psychology*
- GEORGE H. CONNER, M.D. (Illinois) *Professor of Surgery*
- JOHN D. CONNOR, Ph.D. (Philadelphia) *Professor of Pharmacology*
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- DOUGLAS N. COOK, M.A. (Stanford) *Professor of Theatre Arts*
- JOHN A. COOK, M.F.A. (Iowa) *Professor of Art*
- EDWIN L. COOPER, Ph.D. (Michigan) *Professor of Zoology*
- LEE D. CORAOR, Ph.D. (Iowa) *Assistant Professor of Electrical Engineering*
- RANIERO CORBELLETTI, M.S. (Columbia) *Professor of Architecture*
- EDWARD S. CORBETT, Ph.D. (Penn State) *Adjunct Assistant Professor of Forest Resources*
- SAM M. CORDES, Ph.D. (Washington State) *Assistant Professor of Agricultural Economics*
- ROGER N. CORNISH, Ph.D. (Minnesota) *Assistant Professor of Theatre and Film*
- PAUL R. CORNWELL, Ph.D. (Michigan) *Associate Professor of Psychology*
- THOMAS F. COSMIANO, Ph.D. (S.U.N.Y.) *Assistant Professor of Economics*
- ROBERT L. COWAN, Ph.D. (Penn State) *Professor of Animal Nutrition*
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- W. EDWARD CRAIGHEAD, Ph.D. (Illinois) *Professor of Psychology*
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- CHARLES O. CRAWFORD, Ph.D. (Cornell) *Professor of Rural Sociology*
- DONALD M. CRIDER, Ph.D. (Penn State) *Associate Professor of Rural Sociology*
- WILLIAM E. CROCKEN *Associate Professor of Theatre Arts*
- LESLIE E. CROSS, Ph.D. (Leeds) *Professor of Electrical Engineering*
- VIRGIL E. CROWLEY, Ph.D. (Missouri) *Professor of Farm Management Extension*
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- RICHARD G. CUNNINGHAM, Ph.D. (Northwestern), P.E. *Prof. of Mechanical Engineering*
- ROBERT L. CUNNINGHAM, Ph.D. (Washington State) *Prof. of Soil Genesis and Morphology*
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- ANTHONY CUTLER, Ph.D. (Emory) *Professor of Art History*
- PAUL H. CUTLER, Ph.D. (Penn State) *Professor of Physics*
- FRANK DACHILLE, Ph.D. (Penn State) *Professor of Geochemistry*

SABIR H. M. DAHIR, Ph.D. (North Carolina State) *Associate Professor of Engineering*  
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 WILLIAM A. DAMERST, M.A. (Massachusetts) *Professor of English*  
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 ROLAND R. DANIELS, Ph.D. (Wisconsin State) *Assoc. Prof. of Environmental Horticulture*  
 STEVEN J. DANISH, Ph.D. (Michigan State) *Professor of Human Development*  
 RONALD P. DANNER, Ph.D. (Lehigh) *Professor of Chemical Engineering*  
 MUKUNDA B. DAS, Ph.D. (London), D.I.C. *Professor of Electrical Engineering*  
 THOMAS E. DAUBERT, Ph.D. (Penn State) *Professor of Chemical Engineering*  
 ANTHONY R. D'AUGELLI, Ph.D. (Connecticut) *Assoc. Professor of Human Development*  
 ARTHUR B. DAUGHERTY, Ph.D. (Penn State) *Adj. Asst. Prof. of Agricultural Economics*  
 JOHN R. DAUGHERTY, Ph.D. (Colorado State) *Asst. Prof. of Environmental Resource Mgmt.*  
 EUGENE A. DAVIDSON, Ph.D. (Columbia) *Professor of Biological Chemistry*  
 THOMAS B. DAVINROY, D.Eng. (California) *Associate Professor of Civil Engineering*  
 ALAN DAVIS, Ph.D. (Durham) *Professor of Geology*  
 DONALD D. DAVIS, Ph.D. (Penn State) *Associate Professor of Plant Pathology*  
 JOHN W. DAVIS, Ph.D. (Penn State) *Assistant Professor of Industrial Engineering*  
 SAMUEL G. DAVIS, Ph.D. (Syracuse) *Assistant Professor of Management Science*  
 KATHRYN B. DE BOER, Ph.D. (Denver) *Associate Professor of Speech Communication*  
 TARASANKAR DEB ROY, Ph.D. (Inst. of Sci., Bangalore) *Assistant Professor of Metallurgy*  
 REGINALD A. DEERING, Ph.D. (Yale) *Professor of Biophysics*  
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 PETER DEINES, Ph.D. (Penn State) *Associate Professor of Geochemistry*  
 GORDON F. DEJONG, Ph.D. (Kentucky) *Professor of Sociology*  
 JAMES F. DELANSKY, Ph.D. (Cornell) *Associate Professor of Electrical Engineering*  
 VLADIMIR DE LISSOVOY, Ph.D. (Cornell) *Prof. of Child Dev. and Family Relations*  
 PAUL A. DE MAINE, Ph.D. (British Columbia) *Professor of Computer Science*  
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 WILLIAM E. DE MUTH, Jr., M.D. (Pennsylvania) *Professor of Surgery*  
 NORMAN C. DENO, Ph.D. (Michigan) *Professor of Chemistry*  
 ROSA G. DE PENNA, Ph.D. (Buenos Aires) *Professor of Meteorology*  
 JACOB DE ROOY, Ph.D. (Rutgers) *Assoc. Professor of Managerial Economics and Statistics*  
 PHILIP R. DESHONG, Sc.D. (M.I.T.) *Assistant Professor of Chemistry*  
 WILLIAM R. DETAR, Ph.D. (Purdue) *Associate Professor of Agricultural Engineering*  
 WAYNE L. DETWILER, D.Ed. (Penn State) *Assistant Professor of Vocational Education*  
 FRANCINE DEUTSCH, Ph.D. (Penn State) *Asst. Prof. of Child Development and Child Services*  
 FRANK R. DEUTSCH, Ph.D. (Brown) *Associate Professor of Mathematics*  
 STEVEN DEUTSCH, Ph.D. (Penn State) *Res. Assoc. at Applied Research Laboratory*  
 DAVID R. DEWALLE, Ph.D. (Colorado State) *Professor of Forest Hydrology*  
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 PAUL S. DIMICK, Ph.D. (Penn State) *Professor of Food Science*  
 MARK W. DIRSMITH, Ph.D. (Northwestern) *Assoc. Prof. of Acctg. and Mgmt. Info. Systems*  
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 JOHN J. DOCHERTY, Ph.D. (Arizona) *Associate Professor of Microbiology*  
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 JOHN A. TESKE, Ph.D. (Clarke) *Assistant Professor of Behavioral Sciences and Education*  
 ROBERT C. TETRAULT, Ph.D. (Wisconsin) *Associate Professor of Entomology Extension*  
 MARY J. TEVETHIA, Ph.D. (Michigan State) *Associate Professor of Microbiology*  
 SATVIR S. TEVETHIA, Ph.D. (Michigan State) *Professor of Microbiology*  
 HELEN M. THAL, Ed.D. (Columbia) *Professor of Home Economics Education*  
 GEORGE A. THEODORSON, Ph.D. (Cornell) *Professor of Sociology*  
 BARBARA A. THERRIEN, M.N. (Washington) *Assistant Professor of Nursing*  
 C. DALE THERRIEN, Ph.D. (Texas) *Associate Professor of Biology*  
 DENO G. THEVAOS, Ed.D. (Columbia) *Professor of Education and Psychology*  
 JAMES B. THIES, Ph.D. (Northwestern) *Assoc. Professor of Acctg. and Mgmt. Info. Systems*  
 KENNETH A. THIGPEN, Ph.D. (Indiana) *Assoc. Prof. of English and Comparative Literature*  
 HOWARD W. THOELE, Ph.D. (Minnesota) *Associate Professor of Dairy Science*  
 HOBEN THOMAS, Ph.D. (Claremont) *Professor of Psychology*  
 HORACE R. THOMAS, JR., Ph.D. (Vanderbilt) *Assistant Professor of Civil Engineering*  
 TROY THOMAS, Ph.D. (California) *Assistant Professor in Humanities and Art*  
 CARL I. THOMPSON, Ph.D. (Wisconsin) *Associate Professor of Behavioral Science*  
 DONALD E. THOMPSON, Ph.D. (Penn State) *Sr. Res. Assoc. at Applied Research Laboratory*  
 JAMES G. THOMPSON, Ph.D. (Penn State) *Associate Professor of Physical Education*  
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 CHARLES P. THORNTON, Ph.D. (Yale) *Professor of Petrology*  
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 JOHN E. TILTON, Ph.D. (Yale) *Professor of Mineral Economics*  
 NANCY M. TISCHLER, Ph.D. (Arkansas) *Professor of English and Humanities*

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 WILLIAM TOOMBS, Ph.D. (Michigan) *Professor of Education*  
 EMILY TOTH, Ph.D. (Johns Hopkins) *Assistant Professor of English*  
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 KATHRYN TOWNS, Ph.D. (Penn State) *Associate Professor of Educational Psychology*  
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 ALFRED TRAVERSE, Ph.D. (Harvard) *Professor of Palynology*  
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 RICHARD E. TRESSLER, Ph.D. (Penn State) *Associate Professor of Ceramic Science*  
 MARIETTA J. TRETTER, Ph.D. (Wisconsin) *Assistant Professor of Management Science*  
 WILLIAM BRUCE TRINKLEY, M.A. (Columbia) *Associate Professor of Music*  
 ALFRED A. TRIOLO, Ph.D. (Illinois) *Associate Professor of Spanish and Italian*  
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 TIEN-TZOU TSONG, Ph.D. (Penn State) *Professor of Physics*  
 ALBERT G. TSUGAWA, Ph.D. (Michigan) *Associate Professor of Philosophy*  
 CHEN-PEI DAVID TU, Ph.D. (Cornell) *Assistant Professor of Biochemistry*  
 LOREN D. TUKEY, Ph.D. (Ohio State) *Professor of Pomology*  
 BRIAN J. TURNER, D.For. (Yale) *Associate Professor of Forest Management*  
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 RICHARD D. TWARK, Ph.D. (Penn State) *Assoc. Prof. of Quantitative Business Analysis*  
 BEN W. TWIGHT, Ph.D. (Washington) *Associate Professor of Forest Resources*  
 JOHN E. TYWORTH, Ph.D. (Oregon) *Assistant Professor of Business Logistics*  
 WALTER M. TZILKOWSKI, Ph.D. (Massachusetts) *Assistant Professor of Wildlife Ecology*  
 JAMES S. ULTMAN, Ph.D. (Delaware) *Associate Professor of Chemical Engineering*  
 RAYMOND E. UNTRAUER, Ph.D. (Illinois), P.E. *Professor of Civil Engineering*  
 RICHARD F. UNZ, Ph.D. (Rutgers) *Associate Professor of Sanitary Microbiology*  
 M. LEE UPCRAFT, Ph.D. (Michigan) *Assistant Professor of Education*  
 HUGH B. URBAN, Ph.D. (Penn State) *Professor of Human Development and Psychology*  
 PETER D. USHER, Ph.D. (Harvard) *Associate Professor of Astronomy*  
 S. V. UTECHIN, Dr.Phil. (Kiel, Germany) *Professor of Russian History*  
 THEODORE R. VALLANCE, Ph.D. (Syracuse) *Professor of Human Development*  
 ERIC R. VANCE, Ph.D. (Monarch, Australia) *Research Associate*  
 DAVID B. VAN DOMMELEN, M.A. (Michigan State) *Professor of Art Education*  
 JUDITH VAN HERIK, Ph.D. (Chicago) *Assistant Professor of Religious Studies*  
 JAMES E. VAN HORN, Ph.D. (Ohio State) *Associate Prof. of Rural Sociology Extension*  
 M. ALBERT VANNICE, Ph.D. (Stanford) *Associate Professor of Chemical Engineering*  
 ROBERT C. VANNUCCI, M.D. (Jefferson) *Assistant Professor of Pediatrics*  
 WILLEM VAN VLIET, Ph.D. (Toronto) *Assistant Professor of Man-Environment Relations*  
 LEONID N. VASERSTEIN, Ph.D. (Moscow State) *Professor of Mathematics*  
 FRANCIS J. VASTOLA, Ph.D. (Penn State) *Professor of Fuel Science*  
 ELMER A. VASTYAN, B.D. (Episcopal Theol., Cambridge) *Prof. of Human. and Rel. Studies*  
 CARL G. VAUGHT, Ph.D. (Yale) *Associate Professor of Philosophy*  
 KUPPUSWAMY VEDAM, Ph.D. (Indian Institute of Science) *Professor of Physics*  
 DONALD P. VERENE, Ph.D. (Washington) *Professor of Philosophy*  
 ELLIOT S. VESELL, M.D. (Harvard) *Professor of Pharmacology, Genetics, and Medicine*  
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 JOSEPH J. VILLAFRANCA, Ph.D. (Purdue) *Associate Professor of Chemistry*  
 ARMANDO VILLARROEL, Ph.D. (Michigan State) *Adjunct Assistant Professor of Education*  
 WILLIAM A. VOGELY, Ph.D. (Princeton) *Professor of Mineral Economics*  
 BARRY VOIGHT, Ph.D. (Columbia) *Professor of Geology*  
 ROY S. VOLLMER, M.Arch. (Pennsylvania) *Associate Professor of Architecture*



MICHAEL VOLPE, Ph.D. (Temple) *Assistant Professor of Speech Communication*  
 HELEN B. VOLZ, Ph.D. (Penn State) *Assistant Professor of Special Education*  
 FRED W. VONDRACEK, Ph.D. (Penn State) *Associate Professor of Human Development*  
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 JOHN S. WADE, JR., Ph.D. (Tennessee) *Associate Professor of Engineering*  
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 JOHN A. WALDHAUSEN, M.D. (St. Louis School of Medicine) *Professor of Surgery*  
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 JAMES C. WAMBOLD, Ph.D. (New Mexico) *Assoc. Professor of Mechanical Engineering*  
 MIAN-CHANG WANG, Ph.D. (California) *Associate Professor of Civil Engineering*  
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 PATRICIA A. WARD, Ph.D. (Wisconsin) *Assoc. Prof. of French and Comparative Literature*  
 ROBERT M. WARD, M.D. (Johns Hopkins) *Assistant Professor of Pediatrics and Pharmacology*  
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 REX H. WARLAND, Ph.D. (Iowa State) *Professor of Rural Sociology*  
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 THOMAS WARTIK, Ph.D. (Chicago) *Professor of Chemistry*  
 MICHAEL J. WASYLENKO, Ph.D. (Syracuse) *Assistant Professor of Economics*  
 WILLIAM C. WATERHOUSE, Ph.D. (Harvard) *Professor of Mathematics*  
 THOMAS L. WATSCHKE, Ph.D. (Virginia Polytech.) *Assoc. Professor of Turfgrass Science*  
 JAMES R. WATSON, Ph.D. (Illinois) *Associate Professor of Business Administration*  
 ROBERT D. WEAVER, Ph.D. (Wisconsin) *Assistant Professor of Agricultural Economics*  
 RALPH L. WEBB, Ph.D. (Minnesota) *Associate Professor of Mechanical Engineering*  
 HELMUT E. WEBER, Sc.D. (M.I.T.) *Professor of Mechanical Engineering*  
 DAVID L. WEBSTER, Ph.D. (Minnesota) *Associate Professor of Anthropology*  
 FREDERICK C. WEDLER, Ph.D. (Northwestern) *Associate Professor of Biochemistry*  
 DANIEL W. WEEDMAN, Ph.D. (Wisconsin) *Professor of Astronomy*  
 PAUL D. WEENER, Ph.D. (Michigan) *Associate Professor of Educational Psychology*  
 WILLIAM A. WEIDNER, M.D. (Wisconsin) *Professor of Radiology*  
 WALTER B. WEIMER, Ph.D. (Minnesota) *Associate Professor of Psychology*  
 FREDERICK F. WEINER, Ph.D. (Wayne State) *Associate Professor of Speech Pathology*  
 STEVEN M. WEINRED, Ph.D. (Rochester) *Professor of Chemistry*  
 STANLEY WEINTRAUB, Ph.D. (Penn State) *Research Professor of English*  
 SUSAN F. WEIS, Ph.D. (Penn State) *Associate Professor of Home Economics Education*  
 BORIS WEISFEILER, Ph.D. (Steklov's Math. Institute, Leningrad) *Assoc. Prof. of Mathematics*  
 GERALD D. WEISMAN, Ph.D. (Michigan) *Assistant Professor of Man-Environment Relations*  
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 JUDITH WEISZ, M.B., B.Chir. (London) *Professor of Obstetrics and Gynecology*  
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 PAUL W. WELLIVER, Ph.D. (Penn State) *Professor of Education*  
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 HARRY H. WEST, Ph.D. (Illinois), P.E. *Associate Professor of Civil Engineering*  
 PAUL N. WEST, M.A. (Columbia) *Professor of English and Comparative Literature*  
 DAVID L. WESTBY, Ph.D. (Michigan State) *Associate Professor of Sociology*

- FRANCIS L. WHALEY, Ph.D. (Michigan) *Associate Professor of Psychology*  
 ALFRED G. WHEELER, JR., Ph.D. (Cornell) *Adjunct Assistant Professor of Entomology*  
 ERIC R. WHITE, Ed.D. (Pennsylvania) *Affiliate Assistant Professor of Education*  
 EUGENE E. WHITE, Ph.D. (Louisiana State) *Professor of Speech Communication*  
 JOHN W. WHITE, Ph.D. (Penn State) *Professor of Horticulture*  
 WILLIAM B. WHITE, Ph.D. (Penn State) *Professor of Geochemistry*  
 WILLIAM J. WHITE, M.S. (Penn State) *Assistant Professor of Comparative Medicine*  
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 JAMES O. WHITTAKER, Ph.D. (Oklahoma) *Professor of Psychology and Social Science*  
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 THOMAS A. WIGGINS, Ph.D. (Penn State) *Professor of Physics*  
 KENNETH P. WILKINSON, Ph.D. (Mississippi State) *Professor of Rural Sociology*  
 JACK H. WILLENBROCK, Ph.D. (Penn State), P.E. *Associate Professor of Civil Engineering*  
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 EUGENE G. WILLIAMS, Ph.D. (Penn State) *Professor of Geology*  
 FREDERICK M. WILLIAMS, Ph.D. (Yale) *Associate Professor of Biology*  
 JANET A. WILLIAMSON, Ph.D. (Penn State) *Associate Professor of Nursing*  
 SHERRY L. WILLIS, Ph.D. (Texas) *Associate Professor of Human Development*  
 FERN K. WILLITS, Ph.D. (Penn State) *Professor of Rural Sociology*  
 DONALD J. WILLOWER, Ed.D. (Buffalo) *Professor of Education*  
 BRENT G. WILSON, Ph.D. (Ohio State) *Professor of Art Education*  
 DAVID T. WILSON, Ph.D. (Western Ontario) *Professor of Marketing*  
 GEOFFREY L. WILSON, Ph.D. (Loughborough Tech., England), P.E.  
*Associate Professor of Engineering Research*  
 LOWELL L. WILSON, Ph.D. (South Dakota State) *Professor of Animal Science*  
 R. DALE WILSON, Ph.D. (Iowa) *Assistant Professor of Marketing*  
 RICHARD A. WILSON, Ph.D. (Montana State) *Associate Professor of Veterinary Science*  
 LOUIS WINKLER, Ph.D. (Pennsylvania) *Assistant Professor of Astronomy*  
 NICHOLAS WINOGRAD, Ph.D. (Case Western Reserve) *Professor of Chemistry*  
 ELIZABETH WINSTON, Ph.D. (Wisconsin) *Assistant Professor of Humanities and English*  
 JERRY L. WIRCENSKI, Ph.D. (Ohio State) *Associate Professor of Vocational Education*  
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 CARL H. WOLGEMUTH, Ph.D. (Ohio State) *Professor of Mechanical Engineering*  
 FRED H. WOOD, D.Ed. (Missouri) *Professor of Education*  
 ROBERT A. WOOD, Ph.D. (Pittsburgh) *Assistant Professor of Finance*  
 DAWN CLAUDIA WOODERSON, Ph.D. (Florida State) *Assistant Professor of Music Education*  
 LLOYD W. WOODRUFF, Ph.D. (Minnesota) *Associate Professor of Public Administration*  
 PAUL O. WOOLLEY, JR., M.D. (Yale) *Associate Professor of Health Planning*  
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 JAMES E. WRIGHT, JR., Ph.D. (Cornell) *Professor of Genetics*  
 LAUREN A. WRIGHT, Ph.D. (California Tech.) *Professor of Geology*  
 PAUL J. WUEST, Ph.D. (Penn State) *Professor of Plant Pathology*  
 LAKSHAM S. YAPA, Ph.D. (Syracuse) *Associate Professor of Geography*  
 RONALD E. YASBIN, Ph.D. (Rochester) *Asst. Professor of Microbiology and Cell Biology*  
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 WILLIAM G. YENDOL, Ph.D. (Purdue) *Professor of Entomology*



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 BERTRAM YOOD, Ph.D. (Yale) *Professor of Mathematics*  
 THOMAS M. YORK, Ph.D. (Princeton) *Professor of Aerospace Engineering*  
 CARL E. YOUNG, Ph.D. (George Peabody) *Assistant Professor of Human Development*  
 DAVID L. YOUNG, M.L.A. (Harvard) *Professor of Landscape Architecture*  
 PHILIP YOUNG, Ph.D. (Iowa) *Research Professor of English*  
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 ARIAN ZARKOWER, Ph.D. (Cornell) *Associate Professor of Veterinary Science*  
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 WILBUR ZELINSKY, Ph.D. (California) *Professor of Geography*  
 ROBERT F. ZELIS, M.D. (Chicago) *Professor of Medicine and Physiology*  
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 VICKIE L. ZIEGLER, Ph.D. (Yale) *Associate Professor of German*  
 LEONARD N. ZIMMERMAN, Ph.D. (Cornell) *Professor of Bacteriology*  
 RICHARD E. ZINDLER, Ph.D. (Michigan State) *Professor of Engineering Research*  
 GEORGE S. ZORETICH, M.A. (Penn State) *Professor of Art*

# GENERAL INFORMATION

## THE GRADUATE SCHOOL

Graduate work at The Pennsylvania State University was first offered in 1862, but for some time there were few graduate students and graduate instruction was relatively unorganized. A committee of the General Faculty eventually was given the responsibility of establishing standards and regulations governing graduate work and the granting of master's and certain technical degrees. The Graduate School was formally established in 1922 by the President and the Board of Trustees. An administrative staff was organized, and the Graduate Faculty was formed. The University Senate delegated to this faculty responsibility for graduate affairs, subject to review. In 1924 the Board of Trustees authorized the granting of the degree of Doctor of Philosophy. On May 9, 1971, a Graduate Council was established for the Graduate School. Today graduate study is offered in 127 major programs, with 17 advanced academic and professional degrees being conferred. During the academic year 1979-80, 5,700 to 6,300 graduate students were enrolled each term, and 1,752 advanced degrees were conferred, of which 376 were doctorates.

The Graduate School is a member of the Association of Graduate Schools (an organization within the Association of American Universities) and of the Council of Graduate Schools in the United States.

### MAJOR ROLE

The major role of the Graduate School is to emphasize those aspects of University activity which pertain directly to major programs in graduate study. Through its Graduate Faculty it represents a large segment of the academic strength of the University and is thus a dominant force in sustaining and furthering the intellectual quality of the entire institution. The eleven colleges of the University formulate study and research programs appropriate to their fields. The Graduate Faculty consists of those members of the college faculties who have authorization through the Graduate School to offer courses and seminars and supervise research and theses consistent with the highest academic standards. Thus, the Graduate School may be regarded as a federation of selected segments of the college faculties.

### GOVERNANCE

The governance of the Graduate School is vested in a Graduate Council, whose legislative authority is subject to the specific restrictions of the "Articles of Authority." The council forms its own committee structure under bylaws outlined in "Standing Rules of the University Graduate Council."

Executive and administrative matters of the Graduate School are the responsibility of the dean, who is charged directly with enforcement of the regulations of the Graduate School and with organization of its administrative procedures. The dean has a major responsibility to enhance and insure the high quality of graduate study and research of graduate students. He exercises leadership in initiating new programs and in restructuring or phasing out marginal and obsolete ones. The dean encourages and assists in the development of multidisciplinary programs. He is assisted in this work by an administrative and clerical staff.

### ADMINISTRATIVE DIVISIONS

There are four major administrative divisions in the Graduate School to which the students may go directly for answers to questions which require administrative assistance or decisions:

1. *Graduate Admissions*, 201 Kern Graduate Building. The Office of Graduate Admissions has responsibility for processing all matters pertaining to a student's admission.
2. *Graduate Student Programs*, 211 Kern Graduate Building. The functions of the Office of Graduate Student Programs encompass responsibilities for the academic involvement and concerns of all graduate students from the time they are admitted until they graduate, such as (a) registration of students, (b) readmission of students, (c) maintenance of records, (d) appointment of graduate committees for doctoral students, (e) scheduling of graduate student comprehensive and final oral examinations, (f) checking for accomplishment by students of



Graduate Faculty requirements for all advanced degrees and preparation of official commencement lists, and (g) attention to student academic problems.

3. *Graduate Fellowships*, 320 Kern Graduate Building. The Office of Graduate Fellowships serves as a clearinghouse for information on available fellowships and other awards for graduate students, administers fellowships and other award programs involving students in more than one college, and seeks support for graduate students attending the University.
4. *Theses and Publications*, 320 Kern Graduate Building. The Office of Theses and Publications is responsible for reviewing all theses to assure that they meet format requirements consistent with the attainment of high scholarly standards. The office prepares the major Graduate School publications.

## PROGRAMS AT OTHER LOCATIONS

*Behrend College* — The Behrend College at Erie provides convenient opportunity for graduate education to persons residing in northwestern Pennsylvania. It has been established to offer individual courses and a program leading to the degree of Master of Engineering with a major in engineering science.

*Radnor Center for Graduate Studies* — The Radnor Center for Graduate Studies near Philadelphia offers programs leading to the degrees of Master of Engineering with majors in engineering science and industrial engineering, Master of Public Administration, and Master of Education with majors in mathematics, elementary education, and special education.

*The Capitol Campus* — The Capitol Campus, located near Middletown and named for its proximity to the state capital, was opened in 1966. Graduate programs leading to the degrees of Master of Administration, Master of Arts with majors in American studies and in humanities, Master of Education with a major in teaching and curriculum, Master of Engineering with a major in engineering science, Master of Psychosocial Science, Master of Public Administration, and Master of Regional Planning with a major in urban and regional planning are currently offered.

*The Milton S. Hershey Medical Center* — The University's Medical Center was established in 1963, and the first class of medical students entered in the fall of 1967. The center is located in Hershey, Pennsylvania, twelve miles from Harrisburg. In conjunction with The Pennsylvania State University's Graduate School, the College of Medicine offers programs leading to the Master of Science degree with a major in laboratory animal medicine, and to the Doctor of Philosophy and Master of Science degrees with majors in anatomy, biological chemistry, microbiology, pharmacology, and the intercollege programs in genetics and physiology.

## KERN GRADUATE BUILDING

The Kern Graduate Building is named in honor of the late Dean Emeritus Frank D. Kern, who was the first dean of the Graduate School. The Graduate School administrative offices are on the second and third floors of the building.

## GRADUATE COMMONS

The Graduate Commons, located on the first floor of Kern Graduate Building, provides programs, services, and facilities for the graduate community and serves as a common meeting area for faculty and students. The assembly room and multipurpose rooms are used for large group meetings; the smaller rooms are used for committee meetings and similar small group gatherings. These may be reserved by graduate organizations or for events of a University-wide nature.

Food service is provided by the Department of Housing and Food Service in the cafeteria and for special catered events. The lobby contains the Commons Gallery, which displays artwork done by students and faculty and exhibits from sources outside the University. The Commons serves as the home for Graduate Student Association programs such as the coffeehouse, films, concerts, and similar events. Policy governing building use and services is determined by the Graduate Council Committee on Graduate Commons and Related Matters.

The Office of the Director of the Graduate Commons serves as a clearinghouse for the scheduling of events planned by organizations and individuals. Reservations, a periodicals lending library (including daily newspapers), information regarding Graduate Commons activities, recreational equipment, and information of a general nature concerning the Graduate School are available at the Graduate Commons Information Desk. The Commons is open seven days a week during the term session. The operating hours are posted at building entrances. For further information call the Information Desk at 865-1878.

## INTERNATIONAL STUDENT AFFAIRS

The Office of International Student Affairs (OISA) and the International Student Lounge are located in 111 Kern Graduate Building. There are approximately 1,500 international students from 100 countries studying at the various University campuses. Almost 80 percent of these students are enrolled in graduate programs.

Services of OISA include assistance with immigration regulations and tax information; academic, financial, and personal/social counseling; emergency loans; program advising; mail service; housing information; job and travel information; job information in home countries; an international student newsletter; and sponsorship of many clubs and activities.

The International Student Lounge is a comfortable place for international and American students to meet informally. All students are welcome to participate in OISA activities. Announcements of events are posted regularly in the lounge. OISA maintains a library of overseas work/study/travel information, as well as other educational reading materials, including dictionaries, encyclopedias, maps, arts and crafts books, and many newspapers and magazines from around the world. The lounge is available for group meetings upon request.

The OISA works closely with the Community International Hospitality Council, a local community volunteer organization, and the International Council, a student organization which represents international students to the University administration and promotes a variety of social, cultural, and educational programs for the University community.

## GRADUATE STUDENT ASSOCIATION

The Graduate Student Association was established in 1951 as the representative body for graduate students, all of whom are automatically members, and is charged with designating graduate student representatives to a number of committees throughout the University. This volunteer organization provides graduate students with services, programs, and activities not otherwise available through the University. It also provides occasions for relaxation through its social programs. To help defray expenses, the association is partially funded through an allocation from Associated Student Activities, which is under the direction of the assistant vice president for student programs.

The Graduate Student Association Council, the legislative arm of the association, consists of elected delegates from every graduate department, with voting rights proportionate to the number of students in the department. Also included as voting *ex officio* members are the graduate students who have been



elected to serve on the University Faculty Senate (4), the Graduate Council (5), and the University Council (1). All members of the University community are invited to attend the regular monthly meetings of the Association Council. An Executive Board, which consists of the executive officers and division heads, has interim powers to conduct business not requiring the specific action of the Association Council. The executive officers act as official liaison between the association and the dean of the Graduate School.

The Graduate Student Association has established the following divisions and standing committees: *Service Division*: (1) Housing Committee, (2) Publication Committee, (3) Health Committee, and (4) Tax Committee; *Programming/Planning Division*: (1) Coffeehouse Committee, (2) Film Committee, (3) Speakers and Workshop Committee, and (4) Special Events Committee; *Academic Division*: (1) Rules Committee, (2) Research and Advocacy Committee, and (3) Nominating Committee.

In addition, the Association Council may institute *ad hoc* committees and presidential commissions at will. Graduate students are eligible to serve on all committees of the Graduate Council.

The association maintains communication among its members through the campus daily newspaper, scheduled meetings and workshops, and informal use of the Graduate Commons. It publishes annually the *Guide to Graduate Life*, an informal introduction to both the University and the community.

The Graduate Student Association office is at 305 Kern Graduate Building (Tel. 865-9061). Graduate students are encouraged to bring any questions about graduate life to the office for informative, informal conversation.

## FACILITIES

### THE UNIVERSITY LIBRARIES

The University Libraries include a central collection, four subject branch libraries, and one reading room at University Park. Libraries are also located at Hershey Medical Center, Capitol Campus, Radnor Graduate Center, Behrend College, and at each of the seventeen two-year campuses.

At University Park, the central collection, the Arts Library, and the Life Sciences Library are all housed in the Fred Lewis Pattee Library. There are four branch libraries serving the Colleges of Earth and Mineral Sciences, Engineering, Science, and the Department of Mathematics; one reading room in the Department of Architecture; and the Pollock Library in an undergraduate dormitory area. In the reading room and branch libraries are books and journals needed for work assigned in the colleges. Included in the central collection are general reference books and periodicals, works in agriculture, biology, education and psychology, economics and business, the humanities, the natural and social sciences, maps, manuscripts, and government documents.

Among special collections are the Penn State Collection, a Joseph Priestley and a John O'Hara Collection, labor history archives, Audio Archives Collection, Australiana and Utopian literature, the Allison-Shelley Collection of Anglica Americana Germanica, music cassettes, microforms, and a rare book collection.

Special services include the Penntap Information System, which is housed in Pattee Library and serves industries, municipalities, and businesses in the Commonwealth. Several courses in library studies are offered each year by the faculty. In addition, a program of library instruction includes sessions provided as a part of regularly scheduled University courses in cooperation with the course instructors, and topical seminars by library faculty. General library orientation tours are offered at the beginning of each term. Computerized literature searches of selected data bases in engineering, earth and mineral sciences, and in the physical, social, and life sciences are available through the General Reference Section and the related branch libraries.

The University Libraries are a member of numerous cooperative groups. They are one of the four Regional Library Resource Centers established by Pennsylvania law and have memberships in the Association of Research Libraries, the Mid-Atlantic Research Libraries Information Network, the Research Libraries Group, and the Pittsburgh Regional Library Center.

The libraries have approximately 2,330,000 cataloged volumes, 1,050,000 government documents,

23,500 serials, 248,000 maps, 2,000,000 microforms, 3,000 music cassettes, and over 2,000,000 other bibliographical items. Among the special resource guides issued by the library are *Newspapers in Microform*, *Pennsylvania Maps and Atlases*, *Australiana in The Pennsylvania State University Libraries*, *Guide to Sources in Black Studies in The Pennsylvania State University Libraries*, *Centre County, Pennsylvania: A Bibliography and Guide to Sources of Information*, *Voices and Events*, a catalog of audio tapes recorded on the University Park Campus, and the University Libraries Bibliographical Series. Newsletters from the General Reference and the Microforms sections provide up-to-date information on the libraries' resources and services.

## COMPUTATION CENTER

The Computation Center is actively engaged in evaluating and developing modern computing trends and computer systems to meet current job and research needs. Organized as a separate unit under the University Intercollege Programs, the Computation Center provides computing tools and technical services that aid in the education and research programs of all academic departments. Its facilities are heavily used by more than 4,000 graduate students and faculty engaged in research, and by 10,000 undergraduate students doing class assignments; the Computation Center routinely processes more than 15,000 separate computer jobs per day. Computer hardware includes a modern six-megabyte IBM 3033 Processor Complex, about three billion bytes of disk storage, a ten-thousand-reel tape library, and a large configuration of other input/output and telecommunications equipment. Current computer software includes a large repertoire of modern programming language compilers and several thousand library programs. There are sixty-five machine-readable data bases available, including 300 magnetic tape volumes of census data. Access to the computer system can be obtained through high-speed batch terminals (ten on campus, and twenty-two at the two-year colleges). Typewriter terminals may also access the computer system through either the APL time-sharing facility, the Penn State Remote Job Entry file system, or INTERACT/WYLBUR. Except for a few holidays, the Computation Center is open for job processing twenty-four hours a day, seven days a week.

The Computation Center faculty and staff conduct group tours, computer programming workshops, technical seminars, and guest lectures to acquaint the University community with the services available and with advances in computing practices. Computation Center programming consultants provide advice and technical assistance for using library programs, and advice for programming and debugging new applications. Extensive documentation in all areas of related service and programming is provided for graduate students and faculty. The Computation Center offers assistantships to qualified graduate students enrolled in any curriculum. A more detailed summary of facilities and services may be found in the publication *Introduction to the Computation Center*, available in 214 Computer Building.

## LIVING ACCOMMODATIONS

Eastview Terrace and Graduate Circle, both located on the eastern side of the campus and within comfortable walking distance of most of the campus, provide one- and two-bedroom apartments for graduate students with families.

The Eastview Terrace apartments are fire-resistant, steel-framework, one-story buildings. There are forty-six one-bedroom units and thirty-two two-bedroom units. Rent includes utilities (and TV cable) except for electricity, and telephone. Water is heated electrically. The units are unfurnished except for electric stove and refrigerator. For each two units, there is a utility room with two stationary laundry tubs and storage space. Privately owned automatic washers may be installed in apartment kitchens only. No coin-operated facilities are available.

Graduate Circle has 144 one-bedroom apartments and 72 two-bedroom apartments in sixteen two-story buildings of brick and frame construction. Rent includes all utilities (and TV cable) except for telephone. Each kitchen has a double stainless steel sink with disposal unit, a gas stove, kitchen cabinets, and an electric refrigerator. One bedroom has a built-in chest of drawers; otherwise, the units are unfurnished. There are no facilities for private washing machines in the apartments; however, ticket-operated laundries at nominal fees are provided in five of the buildings throughout the area. A basement storage locker is provided for each apartment.



Residence in Graduate Circle or Eastview Terrace Graduate Family Apartments is limited to registered full-time graduate students who are candidates for advanced degrees. All students must live with their spouse and/or preschool children in the apartment. Families with children of school age (including kindergarten) or with children who will come of school age during the term of the lease cannot be considered for occupancy. The one-bedroom units are designed for a graduate student and spouse, and the two-bedroom units for a family with not more than two children. Rates and additional information can be obtained from the Assignment Office for Campus Residences, 101 Shields Building, University Park, PA 16802. Telephone: 814-865-7501

Atherton Hall, located near the Hetzel Union Building, and McKee Hall, located near the Kern Graduate Building, are residence halls which provide combined room and board accommodations for single graduate men and women. Most assignments are made to double rooms since single rooms are available for only one out of three students. Rates for room and board for these halls can be obtained from the Assignment Office.

All rates are subject to change by action of the University.

Information on other living accommodations available in the community may be obtained through:

The Graduate Student Association  
305 Kern Graduate Building  
The Pennsylvania State University  
University Park, PA 16802  
Telephone: 814-865-9061

The Organization of Town Independent Students  
20 Hetzel Union Building  
The Pennsylvania State University  
University Park, PA 16802  
Telephone: 814-865-6851

The State College Area Chamber of Commerce  
131 Sowers Street  
State College, PA 16801  
Telephone: 814-237-7644

Graduate students should arrange for their accommodations well in advance of the beginning of classes, because it may be very difficult to find convenient housing at the last minute. **STUDENTS MUST BE ADMITTED TO THE GRADUATE SCHOOL BEFORE THEIR REQUESTS FOR ON-CAMPUS LIVING ACCOMMODATIONS CAN BE PROCESSED.**

## STUDENT SERVICES

The facilities and services outlined in the following paragraphs are available to graduate students.

### UNIVERSITY HEALTH SERVICES

Located in the central campus area, the Ritenour Health Center is the core of the health service activities and is composed of a dispensary and a hospital. Its facilities are available to full-time graduate students qualifying for nonacademic student benefits and privileges; that is, students registered for 6 or more credits or the equivalent (students holding quarter-time, half-time, or three-quarter-time assistantships).<sup>\*</sup> The outpatient dispensary handles student medical problems from 8:00 a.m. until 4:45 p.m. daily except Saturdays, when hours are from 8:00 a.m. to 11:45 a.m. During other periods, including Sundays and holidays, patients are seen for emergencies only in the Emergency Room of the University Hospital, which is part of the Health Center complex. There is a \$7.50 emergency charge per visit.

<sup>\*</sup>Eligibility is determined by the Graduate School when the I.D. cards are issued.

The University Hospital is well equipped to handle the more serious illnesses and injuries on an inpatient basis. A twenty-five-bed facility, it is staffed with professional personnel twenty-four hours a day during the school terms. Should the need arise for special medical or surgical treatment — major surgery, for example — the student will be transferred to a personally chosen hospital facility.

Included in the Health Center facilities are a dental office for emergency dental care, a physiotherapy department, a pharmacy, and a nutrition clinic.

Hospitalized students will be charged \$45 per day during confinement, and a nominal charge will be made for X-rays and all drugs dispensed to hospital or dispensary patients. Consultation with or treatment by physicians other than the professional staff at the Health Center is at the student's expense. All accounts should be settled before the end of the term in which charges were incurred.

The Ritenour Health Center maintains an ambulance service for local transportation of students with nonambulatory illnesses and injuries.

## HEALTH INSURANCE

Low-cost medical insurance is available for full- and part-time graduate students, including nondegree students, and their dependents. Information concerning the specifics of the policy can be obtained by contacting the Graduate Student Association, 305 Kern Graduate Building, University Park, PA 16802 (Tel. 865-4211).

## MEDICAID BENEFITS

Graduate students may qualify for most of the benefits that apply to hospitalization and medical treatment under Medicaid. Graduate students who are permanent residents of Centre County may apply for state medical assistance to the Office of the Centre County Board of Assistance, Bellefonte, PA 16823 (Tel. 355-5531).

## HEALTH SERVICES FOR CHILDREN

Many medical services are available for children under twenty-one through the State Health Center. The services range from simple immunizations to complicated surgery. Diagnostic study and consultation at the center are made regardless of the ability to pay; however, not all services are free. Children may be referred to the center by physicians or health and welfare agencies. Any preschool child is eligible for free well-child examinations and immunizations. For additional information, contact the Health Center at 110 South School Street, Bellefonte, PA 16823 (Tel. 355- 5438), or consult your doctor.

## CAREER DEVELOPMENT AND PLACEMENT CENTER

The center functions as both a counseling and placement service for students. Its primary purpose is to serve students, both individually and in groups, by assisting them through career and educational counseling in formulating immediate and long-range career plans.

The center cooperates with the colleges and departments of the University to assist students in implementing career plans upon graduation. Services include (1) a library containing information on career opportunities, employer characteristics, and graduate and professional schools; (2) scheduled interviews with prospective employers who are visiting the campus; (3) a file of employment opportunities for which a student may apply by mail; (4) a listing of career-related summer jobs and internships; (5) workshops in interviewing skills, résumé preparation, and looking for a job; (6) a variety of informational meetings and publications; and (7) credential services for candidates seeking positions in educational institutions.

The center is located on the fourth floor of Boucke Building (Tel. 863-0225).



## TUITION AND CHARGES

The University reserves the right to revise the schedule of tuition and charges without further notice.

### TOTAL TUITION FOR EACH TERM IN 1980-81

*University Park Campus and Medical Center* (Nonmedical Students) — 8 or more credits, total charge of \$583 for Pennsylvanians and \$1,166 for non-Pennsylvanians; 7 or fewer credits, \$73 per credit for Pennsylvanians and \$146 for non-Pennsylvanians. These rates apply also to off-campus research and other approved individual study.

*Behrend College, Radnor Graduate Center, and Capitol Campus* — 8 or more credits, total charge of \$531 for Pennsylvanians and \$1,166 for non-Pennsylvanians; 7 or fewer credits, \$61 per credit at Behrend, \$67 per credit at Radnor and Capitol, for Pennsylvanians; \$146 per credit at all locations for non-Pennsylvanians.

*Continuing Education Center* — Tuition for continuing education courses carrying graduate credit will be charged at the prevailing rate at the campus where the courses are offered.

*Vocational Education Program* — 8 or more credits, total charge of \$583 for Pennsylvanians and \$1,166 for non-Pennsylvanians; 7 or fewer credits, \$73 per total program for Pennsylvanians and \$146 for non-Pennsylvanians (vocational education courses are indicated by "v" following the course number).

Tuition is the same for courses whether audited or taken for credit.

Any student who does not fulfill payment obligations promptly may be charged a late payment fee of \$25. A student whose account is delinquent for more than ten days is subject to suspension from the University.

When it appears that an applicant for admission is not domiciled in Pennsylvania, a non-Pennsylvanian classification is assigned. If the student who is thus admitted believes that circumstances do not justify classification as a non-Pennsylvanian, a petition can be made to the Financial Officer for the Dean of the Graduate School, 316 Kern Graduate Building, University Park, PA 16802, for reclassification. (See Student Pennsylvania Resident Status, page 66.)

### TUITION REFUND POLICY

Charges for tuition are refundable upon withdrawal from the University only in the event the student obtains an official Withdrawal Form at the Office of Graduate Student Programs and presents it, together with a current Certificate of Registration, at the Office of the Fee Assessor no later than one calendar month after the effective date of withdrawal from classes. Students who meet these conditions are entitled to receive refunds of charges for tuition for the term, in accordance with the following schedule:

Refund of 80 percent upon withdrawal before the end of the first week of the term (seventh consecutive calendar day from the first day of classes) and a decrease of 20 percent for each week thereafter, up to and including the fourth consecutive calendar week. No amount will be refunded for withdrawal after the fourth consecutive calendar week of the term.

The University will not release any refund of tuition until at least three weeks have elapsed from the date the payment was received. All refunds will be made by check and mailed to the student's home address.

### SPECIFIC CHARGES

In addition to the foregoing tuition and charges, the following charges apply under special conditions and are to be paid independently:

Application fee .....	\$20.00
Change of schedule (each change after first five working days of term).....	6.00
Duplicate meal ticket .....	2.00
Duplicate student identification and activity card .....	each 5.00
Music, individual lessons.....	40.00 to 100.00

Privilege of late payment .....	25.00
Privilege of late registration .....	10.00
Special Ph.D. thesis preparation registration fee (601, 611) .....	128.00
Student parking fee, each term .....	10.00
Teacher placement service registration fee .....	10.00
Teacher placement service reactivation fee .....	10.00
Thesis microfilming and binding fee for master's candidate (one copy) .....	12.50
Thesis microfilming and binding fee for doctoral candidate (one copy) .....	40.00
Transcript of records (with seal), each copy .....	2.00
Mailing diploma in absentia .....	5.00

A student's transcript, diploma, or both, may be withheld until any outstanding financial obligations to the University have been paid.

## MOTOR VEHICLE CHARGES

Each graduate student who possesses, maintains, or operates a motor vehicle (including a motorcycle, motor bike, motor scooter, or any other motor-driven vehicle) while at the University is required to register such vehicle with the Student Traffic Office, 105 Boucke Building, during the registration period of each term. There is no registration charge for students who do not desire campus driving or parking privileges. Failure to register a vehicle renders a student liable for a fine of \$15 or a magistrate's citation for each offense.

A permit allowing limited driving and parking on the campus throughout the week costs \$10 per term. A more restricted permit allowing driving and parking on the campus for evenings and weekends costs only \$3.50 per term.

A graduate assistant pays no fee for the privilege of driving and parking on the campus but is required to comply with student regulations concerning motor vehicles. A graduate assistant receiving any permit must present a valid driver's license and the owner's card for the vehicle each term. Pennsylvania registration of all motor vehicles is required if the student lives for more than thirty consecutive days of the year in Pennsylvania. A student's spouse may be required to register his or her car in Pennsylvania. A *Student Parking and Traffic Regulations* booklet is available in 105 Boucke Building.

*Bicycles* — A bicycle is defined as a two-wheeled vehicle propelled by human power. All bicycles operated on the University Park Campus or in the surrounding community must be registered once each year. Expiration date is May 31. Registration may be obtained at the Department of University Safety, 12 Grange Building, Monday through Friday between 8:00 a.m. and 5:00 p.m. Rules and regulations are available at the time of registration.

## STUDENT AIDS

In every case in which a graduate assistantship, fellowship, grant-in-aid, or scholarship for the next academic year is offered to an actual or prospective graduate student, the student, if acceptance is indicated before April 15, will have complete freedom through April 15 to submit in writing a resignation of the appointment in order to accept one elsewhere. However, an acceptance given or left in force after April 15 commits the student not to accept another appointment without first obtaining a formal release.

Selection of recipients of all University awards is made without regard to the sex, race, religious belief, or ethnic origin or handicap or age of the applicant, as provided by law.

## ASSISTANTSHIPS

Approximately 2,200 graduate assistantships are awarded annually. Most of these are half time, but a limited number of quarter-time and three-quarter-time assistantships are available in some major programs. An appointee may serve as an assistant in classroom or laboratory instruction, in research, or in other work.



*A prospective student should write directly to the person in charge of the intended graduate major program for information and application forms.* Appointments are made subject to the student's admission to the Graduate School as a degree or certificate student. Clear evidence of superior ability and promise is required. Reappointment to an assistantship is based on availability of positions and the quality of the student's work. In most departments or major programs the number of appointment renewals is limited. A common policy is to limit eligibility to two calendar years of study for a master's candidate or five total years for a doctoral candidate.

The assistantships vary as follows (stipend rates are those current in 1981):

**QUARTER-TIME**—The student normally schedules 7-9 credits per term, receives a stipend in the range of \$214-326 per month plus a grant-in-aid of resident education tuition, and is assigned tasks requiring a maximum of 120 hours per term (e.g., ten hours of effort per week for twelve weeks).

**HALF-TIME**—The student normally schedules 5-7 credits per term, receives a stipend in the range of \$428-652 per month plus a grant-in-aid of resident education tuition, and is assigned tasks requiring a maximum of 240 hours per term (e.g., twenty hours of effort per week for twelve weeks).

**THREE-QUARTER-TIME**—The student normally schedules 4-5 credits per term, receives a stipend in the range \$642-978 per month plus a grant-in-aid of resident education tuition, and is assigned tasks requiring a maximum of 360 hours per term (e.g., thirty hours of effort per week for twelve weeks).

The credit load limits specified above may be increased or decreased for a specific term by permission of the assistantship supervisor, provided the total work load is properly balanced in each term and the total credit load over a series of terms is in conformity with the specified limits stated above. Work assigned as a part of assistantship duties for which academic credit is granted need not be counted as a part of the credit limits stated above.

In addition to receiving a grant-in-aid to cover tuition during the term of appointment, a graduate assistant completing three or more consecutive terms of appointment is entitled to a grant-in-aid of tuition for the immediately succeeding term if a scholarship or fellowship is not received from another source for the term. To receive this privilege a student must obtain an Earned Extra Grant-in-Aid Form from the head of the department or program in which the assistantship was held and must follow the instructions on the form in making application.

A graduate assistant may accept concurrent employment outside the University only with permission from the assistantship department head and the assistant's graduate academic program chairman. Concurrent employment normally may not be held with the University. A student may receive a concurrent fellowship supplement.

A graduate assistant pays no fee for the privilege of driving and parking on the campus but is required to comply with student regulations concerning motor vehicles.

## FELLOWSHIPS AND TRAINEESHIPS

About 250 fellowships and traineeships are awarded annually. Recipients must be superior students and are sometimes required to have completed a certain minimum of graduate work before being eligible for an award. Need is also frequently a consideration. Fellows and trainees are required to carry 8-10 credits of course work each term or the equivalent in research, receive stipends which vary with the awards, and usually receive grants-in-aid of tuition. They may not accept employment during the terms of their appointments (except with special permission for training purposes) nor are they required to render any service to the University. In some cases a recipient will be expected to engage in research in a broad field specified by the donor. There is no sharp distinction between a fellowship and a traineeship. Scholarly excellence is always a major consideration and usually the most important criterion in selecting fellowship recipients. Other considerations commonly come first in awarding traineeships.

**GRADUATE SCHOOL FELLOWSHIPS** — A number of fellowships, each paying a stipend of up to \$550/month and providing a grant-in-aid to cover resident education tuition charges, are given by the University and are designated as Graduate School Fellowships. They are available to outstanding graduate students working toward a Ph.D., D.Ed., or M.F.A. degree. The ability of applicants being comparable, some preference is given to students majoring in the humanities and social sciences.

Application forms may be obtained from the Graduate School Fellowship Office, 320 Kern Graduate Building. Applications must be submitted through the applicant's graduate major program and must be received by the Graduate School by the first Monday in February to be considered for the following year. Graduate Record Examination verbal, quantitative, and analytical test scores are required of all applicants.

**SPECIAL GRADUATE SCHOOL FELLOWSHIPS, FELLOWSHIP SUPPLEMENTS, AND GRANTS-IN-AID** — These are open only to students who have been approved for admission but are not yet enrolled in the Graduate School at the time of application. Full fellowships pay up to \$520/month plus resident education tuition. Grants-in-aid provide only tuition. Supplements are small grants in addition to a graduate assistantship or another fellowship. Some supplements are in the form of low-interest loans. Application forms may be obtained from the Fellowship Office, 320 Kern Graduate Building, University Park, PA 16802, and must be submitted through the person in charge of the applicant's graduate major program so as to reach the Graduate School by mid-February to be considered for the following fall. Applicants must arrange to have Graduate Record Examination verbal, quantitative, and analytical test scores sent to the Graduate School by the application deadline.

**MINORITY GRADUATE SCHOLARS AWARDS** — These are fellowships, assistantships, and fellowship supplements granted as a part of the University's comprehensive educational opportunity program. Stipends and qualifications are the same as for other fellowships and assistantships. For further information contact the Graduate School Fellowship Office, 320 Kern Graduate Building.

**FELLOWSHIPS AND TRAINEESHIPS FROM SPECIFIC GRANTS TO DEPARTMENTS AND DIVISIONS BY FOUNDATIONS, INDUSTRIAL CONCERNS, AND FEDERAL AGENCIES** — Over 100 such awards, with various stipends, are granted through individual departments and state and national organizations. Information and application forms may be secured from the person in charge of the appropriate graduate major program. The specific awards will vary somewhat from year to year, but the following are typical of those which were available for 1980-81.

**ADMINISTRATION ON AGING TRAINEESHIPS** — Available to graduate students admitted for study in selected programs; stipend varies. Details available from the Gerontology Center, S-211 Henderson Human Development Building.

**AIRCO SPEER FELLOWSHIP** — Available to a graduate student in ceramic science and engineering for research on carbon and graphite; stipend \$6,000.

**AMAX, INCORPORATED FELLOWSHIP** — Available to a graduate student in metallurgy; stipend \$5,280.

**AMELIA EARHART FELLOWSHIP** — Available to a woman graduate student in aerospace engineering; stipend \$5,000.

**AMERICAN ACCOUNTING ASSOCIATION FELLOWSHIP** — Available to a Ph.D. candidate in accounting; stipend variable up to \$1,000 per year.

**AMERICAN CHEMICAL SOCIETY FELLOWSHIP** — Available to a graduate student in solid state science; stipend \$6,204 plus tuition and fees.

**AMERICAN CHEMICAL SOCIETY FELLOWSHIPS (2)** — Open to graduate students in geochemistry, mineralogy, and solid state science; stipend \$2,400.

**AMERICAN INSTITUTE OF CERTIFIED PUBLIC ACCOUNTANTS FELLOWSHIP** — Available to a Ph.D. candidate in accounting; stipend variable up to \$600 monthly, or \$700 monthly with dependents (maximum of twelve months).

**AMERICAN PSYCHOLOGICAL ASSOCIATION MINORITY PROGRAM FELLOWSHIPS** — Students apply to the Department of Psychology, 417 Moore Building.

**ARTHUR ANDERSON & CO. CONSTRUCTION MANAGEMENT FELLOWSHIP** — Available to a graduate student in civil engineering to support the study phase of his or her graduate work study program in construction management; stipend \$6,000.

**ARTHUR ANDERSON & CO. FOUNDATION FELLOWSHIP** — Available to a Ph.D. candidate in accounting; stipend variable up to \$7,800 (distributed monthly — maximum of twelve months).

**ASARCO FOUNDATION FELLOWSHIP** — Available to a graduate student in mineral economics who is interested in writing his or her thesis on nonfuel mineral products, particularly those produced by the donor; stipend \$2,200.



- BECHTEL POWER CORPORATION POWER PLANT CONSTRUCTION MANAGEMENT FELLOWSHIP** — Available to a graduate student in civil engineering to support the study phase of his or her work study program in power plant construction management; stipend \$2,400.
- BISMUTH INSTITUTE FELLOWSHIP** — Available to graduate students in solid state science; stipend \$5,712 plus tuition and fees.
- CONTINENTAL OIL COMPANY FELLOWSHIP** — Available to a graduate student in petroleum and natural gas engineering for studies in petroleum engineering; stipend variable.
- CONTINENTAL OIL COMPANY FELLOWSHIP IN PETROLEUM ECONOMICS** — Available to a graduate student in mineral economics for studies in petroleum economics; stipend \$1,950.
- COOPERS & LYBRAND FOUNDATION FELLOWSHIP** — Available to a Ph.D. candidate in accounting; stipend variable, up to \$5,000.
- WHEELER P. DAVEY MEMORIAL FELLOWSHIPS** — Available to graduate students in physics; stipend variable.
- DOLOMITE BRICK CORPORATION GRADUATE FELLOWSHIP** — Available to a graduate student in ceramic science and engineering for research on the thermal/mechanical behavior of dolomite refractories; stipend \$6,000.
- DOW CHEMICAL COMPANY FELLOWSHIP** — Available to graduate students in polymer science; stipend \$5,800.
- W. S. ELLIOTT FELLOWSHIP** — Available to a graduate student who is a graduate of The Pennsylvania State University and is interested in engineering research; stipend variable. Apply to Office of the Dean, College of Engineering, 101 Hammond Building.
- ERNST AND WHINNEY FELLOWSHIP** — Available to a master's candidate in accounting, stipend \$1,000; to a Ph.D. candidate with stipend up to \$7,800 (distributed monthly — maximum of twelve months).
- EXCHANGE FELLOWSHIPS IN GERMANY AT KIEL UNIVERSITY** — Available to graduate students in German and other fields for a full academic year. Students must have a good command of German. Stipend approximately \$450 per month plus tuition.
- EXCHANGE TEACHING FELLOWSHIPS IN FRANCE (English Conversation)** — At the University of Strasbourg and the University of Lyon, October-June, renewable. Available to graduate students in French; stipend approximately \$4,700.
- HERMAN G. FISHER GRADUATE FELLOWSHIP** — Available to an advanced graduate student in human development and family studies and especially interested in work with young children; stipend \$5,000 for tuition and other expenses. Apply to the Graduate Program in Human Development and Family Studies.
- FOREST RESOURCES: JESSE ROSSITER RAPP MEMORIAL SCHOLARSHIP** — Available to graduate students in the School of Forest Resources who are not holding assistantships as graduate students. Apply to the School of Forest Resources' Scholarships, Loans, and Awards Committee.
- GENERAL FOODS FUND FELLOWSHIPS (2)** — Available to graduate students with a major in the College of Human Development or in home economics education; stipend \$2,500 for tuition and other expenses. Apply to the Associate Dean for Research and Graduate Studies, S-211 Human Development Building, or the Department of Home Economics Education, 212 Rackley Building.
- GULF OIL COMPANY FELLOWSHIP IN PETROLEUM AND NATURAL GAS ENGINEERING** — Available to a graduate student for work in petroleum production; stipend variable.
- JAMES HAMILTON HARTZELL AND LUCRETIA IRVINE BOYD HARTZELL HISTORY AWARD** — Available to graduate students in history whose field of interest is Pennsylvania history; stipend variable.
- HASKINS AND SELLS FOUNDATION FELLOWSHIP** — Available to a Ph.D. candidate in accounting after candidate's first academic year; stipend in two parts: \$4,000 (last twelve months of course work) and \$8,000 (twelve months during dissertation stage).
- WALTER E. HELLER FELLOWSHIP** — Provided by Walter E. Heller & Company, in the amount of \$1,000 for a candidate for the degree of Master of Business Administration.
- HILL FELLOWSHIPS FOR STUDY IN ANTHROPOLOGY OR HISTORY** — Details available from Dean S.F. Paulson of the College of the Liberal Arts, 108 Sparks Building.
- IBM FELLOWSHIP** — Available to graduate students in solid state science; stipend \$5,400 plus tuition and fees.
- INLAND STEEL FELLOWSHIP** — Available to a graduate student in ceramic science and engineering for research on coke and coal-derived material; stipend \$6,000.

- INSTITUTE OF NUCLEAR POWER OPERATIONS FELLOWSHIPS (3) — Available to graduate students in nuclear engineering; stipend \$5,500 plus tuition.
- INTERNATIONAL LEAD ZINC RESEARCH ORGANIZATION FELLOWSHIP — In support of research on the physics and chemistry of lead and zinc compounds. Available to a student in solid state science; stipend \$2,540.
- JOSEPH M. JOHNSTON MEMORIAL SCHOLARSHIP — Available to a student whose program is related to floriculture; stipend variable. Apply through the Department of Horticulture.
- KAISER FELLOWSHIP — Available to a graduate student in ceramic science and engineering for research on borides and carbides; stipend \$6,000.
- SAMUEL H. KRESS FOUNDATION — Makes available travel grants and research stipends for American students in art history, architecture, and conservation; for doctoral candidates only.
- MICASU SCHOLARSHIP — Available to a graduate student in animal industry who has financial need and who has demonstrated academic achievement and improvement during the graduate program; stipend \$600.
- MINING AND MINERAL RESOURCES RESEARCH FELLOWSHIPS — Available to graduate students majoring in mining and mineral sciences and pursuing M.S. and Ph.D. degrees; stipend \$6,240-7,100 for four terms plus tuition.
- MUSEUM INTERNSHIPS — Available to graduate students in American studies at the Capitol Campus; stipend varies. Apply to Professor Irwin Richman, Professor in Charge of the Graduate Program in American Studies, Capitol Campus.
- NATIONAL INSTITUTE OF AGING TRAINEESHIPS — Available to doctoral students in selected graduate programs for research training in adult development and aging; stipend varies. Details available from the Gerontology Center, S-211 Henderson Human Development Building.
- NATIONAL STEEL CORPORATION FELLOWSHIP — Available to a graduate student in metallurgy; stipend \$5,280.
- MRS. A. ROBERT NOLL GRADUATE FELLOWSHIP IN APPLIED PHYSIOLOGY — For graduate research in applied physiology, especially in environmental or exercise physiology; stipend variable.
- NORTH AMERICAN REFRACTORIES COMPANY FELLOWSHIP — Available to a graduate student in ceramic science and engineering for research on refractories; stipend \$6,000.
- OWENS-CORNING FELLOWSHIP — Available to a graduate student in the geochemistry and mineralogy graduate program; stipend variable, up to \$6,000.
- OWENS-ILLINOIS FELLOWSHIP — Available to a graduate student in ceramic science whose thesis is in the area of glass science and technology; stipend \$6,000.
- P.P.&L. POWER PLANT CONSTRUCTION MANAGEMENT GRANT — Available to a graduate student in civil engineering to support a portion of the study phase of his or her graduate work study program with P.P.&L; stipend \$2,976.
- PENNSYLVANIA MEAT PACKERS' ASSOCIATION SCHOLARSHIP — Open to a selected graduate student specializing in meat science; stipend \$600. Apply through the Department of Dairy and Animal Science.
- PHILLIPS PETROLEUM FELLOWSHIP — Available to a graduate student in the geochemistry and mineralogy program; stipend variable, up to \$6,000.
- PRICE WATERHOUSE FOUNDATION FELLOWSHIP — Available to a Ph.D. candidate in accounting; stipend variable.
- ALEXANDER PROUDFOOT FELLOWSHIP IN EDUCATIONAL PSYCHOLOGY — Available to a student with a strong interest in and aptitude for applying his or her skills in measurement to the problems of human performance in work situations; stipend \$3,600 plus tuition. Apply to Admissions Committee Chairman, Graduate Program in Educational Psychology, 403 Carpenter Building.
- RCA CORPORATION FELLOWSHIP — Available to a graduate student in electrical engineering; stipend \$2,500-3,000 for nine months. May be supplemented for an additional three months on application.
- FRED B. ROONEY TRANSPORTATION SCHOLARSHIP — Established by the Seley Foundation and available to a graduate student in civil engineering who is a permanent resident of either Lehigh or Northampton County, Pennsylvania, and who is specializing in transportation engineering. Apply to the Department of Civil Engineering, 212 Sackett Building.
- SCHOOL OF MUSIC CHAMBER MUSIC FUND SCHOLARSHIPS — Available to graduate and undergraduate students. Contact the School of Music Scholarship Committee for audition information.
- SHAEFFER SCHOLARS PROGRAM — Provided by Charles W. Shaeffer ('33), retired board chairman,



- T. Rowe Price Associates, to M.B.A. candidates evidencing strong academic and managerial potential; stipend \$4,000. Apply to director of M.B.A. program.
- J. WALDO SMITH HYDRAULIC FELLOWSHIP — Established by the American Society of Civil Engineers, Board of Direction, for a graduate student who is preferably an associate member of ASCE. Awarded every third year; \$2,000 for one full academic year, plus a maximum of \$1,000 for research equipment, preferably in the field of experimental hydraulics. More information can be obtained from the Department of Civil Engineering, 212 Sackett Building.
- EDWIN ERLE SPARKS DISSERTATION FELLOWSHIP IN THE HUMANITIES — Available to a doctoral candidate in one of the following graduate programs: classics, comparative literature, English, French, German, history, linguistics, philosophy, religious studies, Slavic languages and literatures, Spanish, and speech communication; stipend \$4,800 plus tuition. Apply to relevant department or program before February 1.
- EDWIN ERLE SPARKS FELLOWSHIPS IN THE HUMANITIES (8) — Available to beginning graduate students in one of the following graduate programs: classics, comparative literature, English, French, German, history, linguistics, philosophy, religious studies, Slavic languages and literatures, Spanish, and speech communication; stipends \$3,800 plus tuition. Apply to relevant department or program before February 1.
- STONE & WEBSTER ENGINEERING CORP. FELLOWSHIP — Available to a graduate student in civil engineering to support the study phase of a work study program in power plant construction management; stipend \$6,240 for four terms.
- TAU BETA PI FELLOWSHIP — Open to any member of Tau Beta Pi, the engineering honor society, for a year of advanced study. Up to eighteen awards of \$3,500 each are available. Applications and information may be obtained from the Office of the Dean, College of Engineering, 101 Hammond Building. Application deadline is February 15.
- TEXACO FELLOWSHIP IN EARTH AND MINERAL SCIENCES — Available to a graduate student in the College of Earth and Mineral Sciences; stipend \$1,200-3,000 plus tuition.
- WALTER THOMAS MEMORIAL SCHOLARSHIP — Available to a student studying the nutrition of horticultural crops; stipend variable. Apply through the Department of Horticulture.
- HARRY F. THOMSON SCHOLARSHIP — Established by the American Concrete Institute for graduate study in the field of concrete. The scholarship is open to any student who is completing studies toward the bachelor's degree or who has received a bachelor's degree from an accredited engineering program. The applicant must be accepted for graduate study of concrete, involving design, materials, construction, or any combination of these subject areas, at a recognized university or college at the time of the award. Information and applications may be obtained from the Department of Civil Engineering, 212 Sackett Building. Application deadline is February 1.
- U.S. DEPARTMENT OF ENERGY WASTE MANAGEMENT TRAINEESHIPS (8) — Available to graduate students interested in a nuclear waste technology master's program; stipend \$5,600 plus tuition.
- U.S. OFFICE OF EDUCATION BILINGUAL EDUCATION FELLOWSHIPS — Available to Ph.D. and D.Ed. candidates preparing for professional careers in bilingual education or a related field; stipend \$6,000 plus tuition, books, and fees. Apply to Director, Bilingual Education Program, Division of Curriculum and Instruction, College of Education.
- U.S. OFFICE OF EDUCATION FELLOWSHIPS IN SPEECH PATHOLOGY AND AUDIOLOGY: WORK WITH THE SPEECH-HANDICAPPED; WORK WITH THE DEAF — Open to graduate students specializing in these fields; stipend up to \$1,200-2,400. Apply to the Communication Disorders Program.
- U.S. OFFICE OF EDUCATION PUBLIC SERVICE FELLOWSHIPS — Available through the Institute of Public Administration at the University Park Campus and the M.P.A. Program at the Capitol Campus; a stipend of \$4,500 for twelve months and tuition. Fellowships are awarded only to students in the Master of Public Administration degree programs at the Capitol Campus and the University Park Campus.
- U.S. OFFICE OF EDUCATION TRAINEESHIPS IN SPECIAL EDUCATION (28) — Open to graduate students being prepared as leadership personnel in special education; stipend \$600 per term plus tuition. Graduate assistantships also available. Apply to the Graduate Admissions Committee, 327 CEDAR Building.
- U.S. OFFICE OF EDUCATION TRAINEESHIPS IN THERAPEUTIC RECREATION — Open to graduate students specializing in therapeutic recreation; stipend \$2,250 (three terms). Apply through the Graduate Program in Recreation and Parks.

- U.S. PUBLIC HEALTH SERVICE TRAINEESHIPS IN CLINICAL PSYCHOLOGY (10) — Available through the Department of Psychology; stipend \$3,780 for nine months plus tuition.
- U.S. PUBLIC HEALTH SERVICE TRAINEESHIPS IN NURSING — Open to selected registered nurse students in nursing; stipend \$3,000 plus tuition. Apply to Professor in Charge, Graduate Program in Nursing.
- U.S. PUBLIC HEALTH SERVICE TRAINEESHIPS IN LABORATORY ANIMAL MEDICINE — Available to selected graduate students in laboratory animal medicine who are planning research-oriented careers; stipend varies. Apply to the graduate program in laboratory animal medicine (Hershøy).
- U.S. PUBLIC HEALTH SERVICE TRAINEESHIPS IN RESEARCH ON LIFE SPAN DEVELOPMENT AND THE FAMILY — Open to selected post-master's graduate students in human development and family studies who are interested in research on the mental health aspects of individual and family development; stipend \$3,900. Apply to Graduate Program in Human Development and Family Studies.
- U.S. PUBLIC HEALTH SERVICE TRAINEESHIPS IN SOCIAL GERONTOLOGY (12) — Open to selected post-master's graduate students in the social and behavioral sciences; stipend \$5,025. Apply to Director, Program in Adult Development and Aging, S-110 Henderson Human Development Building.
- U.S. REHABILITATION SERVICES ADMINISTRATION TRAINEESHIPS IN SPEECH PATHOLOGY AND AUDIOLOGY (7) — Open to graduate students specializing in speech pathology and audiology and hearing impaired; stipend up to \$2,400-4,100. Apply to the Communication Disorders Program.
- VETERANS ADMINISTRATION INTERNSHIPS IN CLINICAL PSYCHOLOGY — A limited number of internships in veterans administration agencies (hospitals and clinics) are available to graduate students in clinical psychology upon direct application to the agency's chief psychologist with endorsement by the Department of Psychology. Stipend variable.
- ARTHUR YOUNG AND COMPANY FELLOWSHIP — Open to a master's degree candidate in accounting from a predominantly black college. Contact the department in the College of Business Administration.

In addition, grants are available from governmental agencies, industrial concerns, foundations, and the armed forces for graduate study and frequently for support of investigations of particular problems. Some of these permit full-time study and carry the same exemptions as the fellowships listed above. Detailed information may be secured from the department of specific interest.

**EXTERNALLY SPONSORED FELLOWSHIP AND TRAINEESHIP PROGRAMS** — Attention is directed to the following national programs, involving numerous fields of study, with which the University cooperates by providing local administration. (See Statement of Nondiscrimination, page 64.)

**FEDERAL HIGHWAY ADMINISTRATION FELLOWSHIPS** — Provided by the Federal Highway Administration, U.S. Department of Transportation, to develop the expert manpower needed to carry out state and local jurisdiction highway programs. Open to qualified students for graduate study in traffic engineering and other highway-related areas. Only U.S. citizens are eligible. Fellowships are granted for an academic year at \$6,000 each for tuition, books, and living stipends. Application forms are available from the National Highway Institute, U.S. Department of Transportation, Washington, DC 20590.

**INTERNATIONAL UNIVERSITY FELLOWSHIPS IN SPACE SCIENCE** — These graduate and postdoctoral fellowships are available to foreign nationals who hold the equivalent of Master of Science or Master of Engineering degrees and meet graduate student entrance requirements at United States universities. Details on the program will be found in the brochure concerning these fellowships issued by the Office of Scientific Personnel, National Academy of Sciences, Washington, DC 20418.

**NATIONAL SCIENCE FOUNDATION FACULTY FELLOWSHIPS** — The Graduate School coordinates a program of awards to young college and university teachers (U.S. citizens only) wishing further training or research experience. Awards are made for all or part of a year or for a succession of summer terms. Stipends are related to current academic salary. Application materials may be obtained from the National Science Foundation, Washington, DC 20550.

**NATIONAL SCIENCE FOUNDATION GRADUATE FELLOWSHIPS AND MINORITY GRADUATE FELLOWSHIPS** — The Graduate School cooperates in this program of prestige fellowships requiring outstanding credentials. These fellowships are available in the biological, engineering, mathematical, physical, and social sciences, as well as the history and philosophy of science. Application is made during the fall to



the Fellowship Office, National Academy of Sciences, National Research Council, 2101 Constitution Ave., N.W., Washington, DC 20418, which has charge of evaluating applicants for the foundation. The stipend is \$325 per month for three years plus remission of tuition. The application deadline for 1981 was November 26, 1980.

**U.S. OFFICE OF EDUCATION MINING AND MINERAL AND MINERAL FUEL CONSERVATION FELLOWSHIPS** — Available to individuals in appropriate majors working for M.S. or Ph.D. degrees who are U.S. nationals. Thirty-four fellowships were awarded in 1980. Award is based on need, significance of planned research, and academic promise. Stipend is \$375 per month. Application procedures are the same as for Graduate School Fellowships. Awards are often supplemented by additional support.

## OTHER AIDS

**GRADUATE SCHOOL TUITION GRANTS-IN-AID** — About forty grants of tuition remission for full-time study are awarded each term. They are available to any graduate degree or certificate student in the third or later term at the University on criteria of financial need and academic promise. A recipient must carry 8 to 10 credits of graduate work but may accept employment of not more than ten hours per week with the University or another employer. Applications for grants for the winter, spring, and summer terms must be filed by the third week of the preceding term and by early April for the fall term. Application forms may be obtained from the Graduate School Fellowship Office, 320 Kern Graduate Building.

**THE RUTH YOUNG BOUCKE GRADUATE FELLOWSHIP** — Established from the estate of Ruth Young Boucke, whose husband was for many years a professor of economics, this fellowship is available every other year to an outstanding graduate student on the same basis as the regular Graduate School fellowships, and selection is made by the Graduate School Committee on Fellowships and Awards. The stipend is up to \$600 per month plus a grant-in-aid of the \$141 thesis preparation fee.

The following loans are available only to students in specific graduate programs.

**THE U.S. ENVIRONMENTAL PROTECTION AGENCY SPECIAL AIR POLLUTION LOAN FUND** — This fund has been established through the University's Center for Air Environment Studies. Recipients must be in the terminal year of their program and pursuing a career in air pollution control. Repayment must be completed within three years of graduation. Interest accrues at an annual rate of 3 percent. If the recipient works for two years following graduation for an air pollution control agency, no repayment is required. Apply through the Center for Air Environment Studies.

**THE UNITED STATES STEEL FOUNDATION LOAN FUND** — This fund provides loans for emergencies and to supplement fellowships. Recipients must be U.S. citizens who are enrolled full time in graduate programs in the Colleges of Earth and Mineral Sciences, Engineering, or Science. Further information may be obtained from the Graduate School Fellowship Office, 320 Kern Graduate Building.

**EMPLOYMENT AND LOAN PROGRAMS** — Any prospective or current graduate degree candidate who is a U.S. citizen or permanent resident may seek aid from the federally funded loan and employment programs listed below directly through the Office of Student Aid, 335 Boucke Building.

To be considered for these aid programs, a prospective graduate student must

1. file by February 15 a Financial Aid Form (FAF), a document used to assess a student's financial need, with the College Scholarship Service, Box 176, Princeton, NJ 08540 or file a Graduate and Professional School Financial Aid Summary (GAPSFAS) with the Educational Testing Service, Box 2614, Princeton, NJ 08541.
2. file by April 1 an Application for Financial Aid and a Financial Aid Transcript with the Office of Student Aid. For each postsecondary institution the student has attended at which he or she has received financial aid, a separate Financial Aid Transcript, certified by that institution, must be submitted. This form is available from the Office of Student Aid.

On-time applications receive first consideration. Because funds are limited, applications filed after the deadlines are considered only as funds permit. Aid is never automatically awarded for subsequent

years. Students must reapply each year for funds. Students planning to attend the summer term must file separate applications.

**THE FACULTY AIDE PROGRAM** is a part-time employment program awarded to graduate students who show a documented financial need. Graduate students who enroll for 4 or more credits are considered. Responsibilities and assignments are similar to those associated with graduate assistantships. This type of aid is not recommended for a student who accepts a graduate assistantship because of the difficulty of working two jobs concurrently and the potential for a student's total aid resources to exceed his or her documented financial need.

**THE NATIONAL DIRECT STUDENT LOAN (NDSL)** program makes low-interest loans available to full-time students with a documented financial need. Repayment begins after graduation or termination of graduate work at a 4 percent interest rate. The maximum loan for one year is \$2,500.

**UNIVERSITY LOANS** are funds established by University organizations, alumni, faculty, staff, and friends to help students who have a documented financial need. Repayment and accrual of 6 percent simple interest begins immediately upon graduation or termination of study. The maximum loan for one year is \$5,000.

**THE GUARANTEED STUDENT LOAN (GSL) PROGRAM** provides low-interest loans to students enrolled on at least a half-time basis. The loans are repayable after the student graduates or terminates his or her education. This federal financial aid program is a cooperative effort of the federal government, state government and/or guarantor agency, a commercial lending institution, and the educational institution.

An application should be obtained from a lending institution which agrees to participate with the student in this program. The loan is available on an interest-free basis to all students during their graduate enrollment, regardless of family income. While enrolled, a student's interest payments on the outstanding loan principal are paid by the federal government. A graduate student may borrow up to a total of \$25,000, including any Guaranteed Student Loans received for undergraduate study. The maximum loan for one year is \$5,000. For students who are first-time GSL borrowers and acquire loans for a period of enrollment after January 1, 1981, the interest rate will be 9 percent. GSL borrowers with previous 7 percent loans will continue to receive additional loans at the 7 percent interest rate.

When seeking aid, the prospective student should keep in mind the following:

*Cost of Attendance* — In determining a student's need in 1980-81, the Office of Student Aid used the following estimates of expenses for an academic year (three terms) as a basic guide. (Estimates are increased for students with dependents.)

	<i>PA Residents</i>	<i>Non-PA Residents</i>
Tuition	\$1,749	\$3,498
Room & Board	1,830	1,830
Books	240	240
Miscellaneous	1,473	1,473
Total Estimated Costs	\$5,292	\$7,041

In 1980-81, tuition for Pennsylvania residents at Behrend, Capitol, and Radnor was \$1,593.

*Nondegree Students* — Financial aid is available for graduate students who are degree candidates only. Nondegree graduate students are not eligible for assistance.

Additional information may be obtained from the Office of Student Aid, 335 Boucke Building, University Park, PA 16802. In corresponding with this office, specify that you are a current or prospective graduate student, and if the latter, the term you wish to begin graduate study at the University.

**GIRARD EDU-CHECK PLAN** — The University offers to sponsors (including parents) of students the Assured Education Plan, enabling them to pay out of current income, on a monthly basis, University bills for tuition, residence hall room and board, and all other items billed by the University. Life insurance and total and permanent disability insurance are a part of the plan for the sponsor up to the sixty-eighth and sixty-first birthdays, respectively. Payments are handled through the Girard Bank, 1339 Chestnut Street, Philadelphia, PA 19107. Further information and application forms may be obtained from the Office of the University Bursar, 103 Shields Building. Signed agreements should be received well in advance of registration, since it takes at least three weeks for completion of arrangements.



**STUDENT EMPLOYMENT** — Many students depend upon part-time employment to help meet their expenses. Students who are thus employed, however, must recognize the time demands of their work schedules and will be required to adjust their academic loads accordingly. The Office of Student Employment, 301 Boucke Building, offers assistance in finding part-time employment in town, as well as on campus. This office also provides the student with assistance in finding summer employment. The Office of Student Aid coordinates the Faculty Aide program, described above under Loan and Employment Programs.

Local placement services and the University Office of Personnel maintain files of positions open to spouses of students.

A student holding a fellowship or traineeship may not accept employment of any kind for service without special advance approval. A graduate assistant may accept concurrent employment outside the University only after obtaining permission from the department head and person in charge of the major program. Concurrent appointments with the University other than a Fellowship Supplement normally may not be held.

**VETERANS' BENEFITS** — The coordinator of veterans affairs has the responsibility of handling all applications for benefits under the various public laws. Veterans who intend to enroll at the University should contact the Veterans Outreach Office, 135 Boucke Building, University Park, PA 16802, as far in advance as possible to obtain information and necessary forms. The Outreach Office also provides information on other programs and services unique to veterans.

Under P.L. 89-358, a student is entitled to benefits if registered full time for 8 or more credits, unless the department head certifies that fewer credits constitute a full-time academic load for that student (see Full-Time Academic Status, page 71).

At each registration, a special veterans (V) card must be submitted to confirm enrollment and academic status. Submission of this card does not generate benefits which are not already certified, but failure to submit the card results in immediate interruption of VA benefits.

Veterans in their first term may defer tuition and room and board fees until their benefit checks begin to arrive.

Federal law and Veterans Administration regulations specify the conditions under which veteran students and eligible dependents are paid VA educational benefits. Veterans Administration benefits are paid under the standards of academic progress and policies relating to student conduct contained in this bulletin and which apply to all graduate students. In addition, certain special conditions for payment of VA educational benefits must be met:

1. Courses which do not meet graduation requirements in the student's approved major (the major which the student has declared to the VA) cannot be computed as part of the student's course load for payment of VA benefits.
2. Unless mitigating circumstances exist, VA benefits cannot be paid for attendance of any portion of a course or term that is not completed.
3. Unless *specific documentation* of an identifiable professional or academic goal can be provided (e.g., teachers requiring 24 graduate credits to obtain permanent certification), no veteran or eligible dependent may be certified for payment of VA educational benefits for any term subsequent to one during which he or she accumulates 12 credits on a nondegree status.
4. Since a 3.00 cumulative grade-point average is required for graduation, graduate student veterans and eligible dependents will be warned that their VA educational benefits may be suspended if their cumulative grade-point average falls below 3.00 during any given term. If the student's average remains below 3.00 for a second consecutive term, the VA certifying official will request a determination of whether progress has been satisfactory from the appropriate department head. If it has not, the VA certifying official will suspend benefits and report the veteran to the VA for lack of satisfactory progress.
5. Veterans and eligible dependents must report any change in academic status (change of credit load, change of major, etc.) to the Office of Veterans Affairs or other appropriate VA certifying official promptly and personally.

## PROCEDURES AND REGULATIONS

A student is expected to assume full responsibility for knowing the regulations and pertinent procedures of the Graduate School as set forth here in the *Graduate Degree Programs* catalog and in the *Thesis Information Bulletin*, and for meeting the standards and requirements expressed by these regulations. Copies of the graduate catalog are available from the Graduate Commons Information Desk, 113 Kern Graduate Building; the *Thesis Information Bulletin* can be obtained from the Office of Theses and Publications, 320 Kern Graduate Building. Graduate students are encouraged to contact the Office of Graduate Student Programs, 211 Kern Graduate Building (Tel. 865-1834), for guidance if they have any questions, uncertainties, or difficulties concerning any procedure or regulation of the Graduate School or any procedure or regulation of the University as it may affect them.

### STATEMENT OF NONDISCRIMINATION

The Pennsylvania State University, in compliance with federal and state laws and regulations governing affirmative action and nondiscrimination, does not discriminate in the recruitment, admission, and employment of students, faculty, and staff in the operation of any of its educational programs and activities as defined by law. Accordingly, nothing in this publication should be viewed as directly or indirectly expressing any limitation, specification, or discrimination as to race, religion, color, or national origin; or to handicap, age, sex, or status as a disabled or Vietnam-era veteran, except as provided by law. Inquiries concerning this policy may be directed to the vice president for student affairs.

### ADMISSION

Each step of the educational process, from admission through graduation, requires continuing review and appropriate approval by University officials. The University, therefore, reserves the right to change the requirements and regulations contained in this bulletin and to determine whether a student has satisfactorily met its requirements for admission or graduation, and to reject any applicant for admission for any reason the University determines to be material to the applicant's qualification to pursue higher education.

An applicant for admission to the Graduate School should understand that graduate work is not a simple extension of an undergraduate program but, rather, demands scholarship of a higher order, and emphasizes research, creativity, and professional competence with a minimum of formal requirements and a maximum of student initiative and responsibility.

*Objective* — The objective of the Graduate School is to admit a qualified graduate student body up to the limit of the University's resources to provide outstanding graduate programs. In general, a student may begin graduate work in fall, winter, spring, or summer.

Applicants must recognize that staff, facilities, and other resources are limited, so that not all qualified persons can be admitted. The number accepted will vary by program, and from term to term. In some graduate programs all vacancies will have been filled long before the general Graduate School deadline for submitting applications, so that even outstanding students cannot be accepted.

*Application* — Applicants interested in graduate programs offered at University Park or The Milton S. Hershey Medical Center should apply to University Park. Those interested in programs at the Capitol Campus, the Radnor Center for Graduate Studies, or Behrend College should apply directly to the appropriate campus. Students are normally expected to begin work at the campus to which they are admitted.

*Qualifications* — For admission to the Graduate School, an applicant must have received, from an accredited institution, a baccalaureate degree earned under residence and credit conditions substantially equivalent to those required by The Pennsylvania State University. Ordinarily, an entering student must have completed in a satisfactory manner a minimum of course work in designated areas, the specific courses and amount of work depending upon the field of advanced study. All applicants must submit Graduate Record Examination Aptitude Test scores. Individual graduate programs and departments may require Advanced Test scores.

A baccalaureate degree holder with a slight deficiency in undergraduate preparation may be admitted and allowed to schedule a limited number of undergraduate courses to remove the deficiency while pro-



ceeding in the graduate program. Courses taken for this purpose do not apply toward the requirements of the advanced degree.

*Provisional admission* may be granted to applicants whose credentials are not complete at the time of application because the baccalaureate degree has not yet been conferred, grades for the current term are not yet available, GRE scores have not yet been reported, etc. Such admission is subject to cancellation if the complete credentials, on arrival, do not meet the requirements for admission. In the interim, certification of any earned credits will be withheld. If admission is canceled for any reason, the student is thereby automatically dropped from the Graduate School.

Admission is granted jointly by the Graduate School and the department or graduate program in which the student plans to study. The establishment of standards by which applicants are admitted is a departmental or program responsibility. Although the Graduate School has no fixed minimum grade-point requirement for admission, an applicant is generally expected to maintain a junior-senior grade-point average of at least 2.50 on The Pennsylvania State University grading scale of A (4.00) to D (1.00). Individual programs may establish higher grade-point average requirements and use other criteria to judge candidates for admission. In exceptional cases, departments or major programs may also approve admission by reason of special backgrounds, abilities, and interests. Departmental or program requirements are given in the descriptive statements appearing under the major programs listed in the latter part of this publication.

A student who has been admitted to a program in which the doctorate is offered may begin working toward that degree but has no official status as a doctoral student and no assurance of acceptance as a doctoral candidate until a candidacy examination administered by the major department or committee has been passed.

*Forms* — Application forms may be obtained from the Office of Graduate Admissions. Applicants may apply for admission to only one program at a time. All academic records, including an explanation of the grading system used, should be submitted, *in duplicate*, to the Office of Graduate Admissions, 201 Kern Graduate Building. These must be received from all institutions by the Graduate School at least one month prior to the opening of the term in which the student plans to begin a graduate program.

*Deadlines* — The deadline for processing of applications by the Graduate School is one month prior to the beginning of any given term. **GRADUATE MAJOR PROGRAMS MAY REQUIRE EARLIER DEADLINES.** A complete Graduate School admissions file, which is required for processing an application, includes the following items: (1) application form, (2) application fee form, (3) a check or money order in the amount of \$20.00 made payable to The Pennsylvania State University, and (4) duplicate transcripts from each institution of higher education attended. Supplementary materials and examination scores may be required in individual programs. If the admission file is incomplete a month prior to the beginning of the term for which the student has applied, the materials will be processed for the first term following the completion of the admissions file.

*Special Nondegree* — A student who plans to take courses for transfer to another institution or to follow a program of study not leading to an advanced degree at this institution should apply for admission as a special nondegree student. The adviser for such a student is appointed by the Graduate School. The number of special nondegree students who can be admitted is limited because preference is given to students in degree programs.

*Minority Students* — Minority students are encouraged to apply for admission to any of the programs offered in the Graduate School. Information concerning programs and financial aid may be obtained from the chairman of the graduate program or the dean of the college of the student's major interest.

*International Students* — International students should plan to apply at least six months prior to the beginning of the term in which they intend to begin graduate studies. They must submit, *in duplicate*, certified English translations of all academic records. In addition, all international students whose native language is not English must take the TOEFL (Test of English as a Foreign Language) and submit the results of this test with the application for admission. A student must present a minimum TOEFL score of 550 to be considered for admission. International students who have been admitted to graduate study with TOEFL scores of 550 or higher will be considered to have met the Graduate School's English language requirement. Information about the TOEFL can be obtained by writing to the Educational Testing Service, Box 899, Princeton, NJ 08541. Like other applicants, international students must submit Graduate Record Examination scores. International students are admitted only as degree stu-

dents unless a sponsoring agency requests a different classification. Such students must also fulfill the Graduate School English language proficiency requirement.

**UNDERGRADUATE STUDENTS** — A student of The Pennsylvania State University who is within 3 credits of completing the baccalaureate degree may be provisionally admitted to the Graduate School. This limit may be increased to 8 credits in the case of a student with an average of at least B (a grade-point average of 3.00). Any senior with a 3.50 grade-point average may be admitted to 500-level courses with the consent of the instructor; other students of at least tenth-term standing with a B average or better may be admitted to graduate courses with the consent of the instructor, the student's academic adviser, and the associate dean of the Office of Graduate Student Programs.

In certain cases undergraduate students may subsequently apply credits they have earned in 400- and 500-series courses toward an advanced degree at The Pennsylvania State University. Upon admission to the Graduate School, and with the approval of the major field, those credits *relevant* to the graduate program of study which were not used to satisfy undergraduate requirements may be applied toward an advanced degree. The time limitation on the completion of a master's degree program applies to these, as well as to other, credits.

**POSTDOCTORAL FELLOWS, SCHOLARS, AND GUESTS OF THE UNIVERSITY** — Individuals holding the highest degree in their field from The Pennsylvania State University or other accredited colleges and universities are invited to apply to the dean of the Graduate School for guest privileges for purposes of noncredit study. Guests may attend seminars and courses with the privileges of faculty members and, if space and facilities are available, carry on research. Individuals with support from an outside agency are commonly given the title of postdoctoral scholar or postdoctoral fellow. Individuals may also be appointed to temporary positions in all University ranks. All guests are expected to affiliate formally or informally with one of the departments, institutes, or other subdivisions of the University engaged in scholarly pursuits.

It is the policy of the Graduate School not to permit applicants to work for a second doctoral degree.

**STUDENT PENNSYLVANIA RESIDENT STATUS** — When it appears that an applicant for admission is not domiciled in Pennsylvania, it is assumed that the applicant is a non-Pennsylvanian. If a student who is thus admitted believes that the circumstances do not justify classification as a non-Pennsylvanian, a written petition for reclassification may be filed with the financial officer of the Graduate School, 316 Kern Graduate Building, University Park, PA 16802. Capitol Campus students may petition the Capitol Campus financial officer.

A copy of the *Policy for Determination of Eligibility for Reclassification as a Pennsylvania Resident for Tuition Purposes* can be obtained in the office of the financial officer mentioned above. Under the rules of this document, when a written petition for reclassification is made, the petitioner is required to present proof of bona fide domicile within the Commonwealth or such other evidence as is pertinent to a complete review of the student's classification. Upon review, a decision by the highest designated authority at the University shall constitute an exhaustion of administrative remedies.

Any reclassification resulting from a student's challenge shall be effective for tuition purposes as of the date such challenge was filed. A student who changes domicile from Pennsylvania to another state must promptly give written notice to the University.

## CLASSIFICATION OF STUDENTS

A graduate student may be admitted either as a degree student or as a special nondegree student, depending upon the student's objectives. After admission to one of these categories, any change to the other must be arranged through the Office of Graduate Student Programs.

**DEGREE STUDENTS** — A degree student is one who plans to become a candidate for an advanced degree at The Pennsylvania State University and who has been formally admitted for advanced studies in a particular program. The program of study is developed under the guidance of an adviser appointed by the head of the student's major program. A degree student who has passed a candidacy examination is classified as a doctoral candidate.



**PROVISIONAL ADMISSIONS** — Provisional admission is a temporary classification in which an applicant may remain for a period no longer than the three terms following admission or the time it takes to accrue 12 credits, whichever comes first. If the deficiencies which caused the provisional admission are not corrected by this time, the student will be dropped from the program.

**SPECIAL NONDEGREE STUDENTS** — An applicant who meets all requirements for admission to the Graduate School, but who does not wish to work for an advanced degree at this institution, may arrange for a program of work as a special nondegree student. This classification includes students who plan to transfer credits to another institution, casual students, and those who plan special programs of study not connected with a specific department and not leading to an advanced degree. The number of special nondegree students who can be admitted directly by the Graduate School is limited, and it is increasingly difficult to provide for them because of the limitation of resources. Preference is given to students in degree programs.

Special nondegree students who are applying for admission to the University Park Campus *must* submit two transcripts from each institution attended. Transcripts should be sent to the Office of Graduate Admissions, 201 Kern Graduate Building, The Pennsylvania State University, University Park, PA 16802. Applications and credentials must be received at least one month prior to the anticipated term of enrollment. A maximum of 12 credits earned as a special nondegree student may be applied to a degree program.

**CERTIFICATE STUDENTS** — A certificate student is one who is engaged in a program of study leading to a certificate or equivalent recognition of accomplishment rather than a graduate degree program at The Pennsylvania State University. Certificate students have the same University privileges and responsibilities as graduate degree students.

**UNDERGRADUATE STUDENTS** — Such a student is not a graduate student since a baccalaureate degree has not been earned. The student may not register for graduate courses or research (500 and 600 series) without permission from the Office of Graduate Student Programs. A student having attained junior standing in college may register for 400-level courses and is admitted through undergraduate admissions.

## PROGRAMS

**MAJOR PROGRAM** — A student's major program is the field of primary interest and the one in which the greater portion of graduate work is taken. Programs are designed to prepare students to assume positions of informed and responsible authority in their fields and to contribute creatively to them. They promote not only specialization, but also breadth of scholarship, the ability to study and think independently, and familiarity with the principal techniques and important literature in the field. The research undertaken by the candidate should deal with a problem which represents a significant contribution to knowledge.

**SPECIAL INTERDISCIPLINARY MAJORS** — In addition to the graduate major programs listed in this bulletin on pages 87-88, special interdisciplinary majors involving two or more departments within a single college, or intercollege majors involving two or more colleges, may be arranged with the approval of the dean of the Graduate School. These programs are offered under the supervision of appropriate interdepartmental or intercollege committees.

In general, departments of the University are identified with specific major programs. Thus, aerospace engineering is a major program of study which is offered under the supervision of the Department of Aerospace Engineering. On the other hand, acoustics and genetics are major programs for which there are no corresponding departments. In such cases, a committee of the Graduate School is responsible for administering the program. In some cases a single department offers work in more than one program. For instance, the Department of Material Sciences offers work in ceramic science, fuel science, metallurgy, and mineral processing.

Applicants for admission are encouraged to consult the person whose name is listed under the major program heading in the Programs and Courses section.

## ADVANCED DEGREES OFFERED

The degrees of Doctor of Philosophy and Doctor of Education are conferred by the University. Both require high attainment and productive scholarship, but the Ph.D. places a strong emphasis on research, whereas the D.Ed. emphasizes professional competence in some field of education.

The Master of Arts and the Master of Science degrees are academic in nature, the programs placing strong emphasis on basic knowledge and research. The professional master's degrees conferred are the Master of Administration, Master of Agriculture, Master of Architecture, Master of Business Administration, Master of Education, Master of Engineering, Master of Environmental Pollution Control, Master of Fine Arts, Master of Forest Resources, Master of Music, Master of Psychosocial Science, Master of Public Administration, and Master of Regional Planning.

Candidates for the M.Adm., M.P.A., M.Ps.Sc., or M.R.P. degree may meet all the requirements for these degrees at the Capitol Campus of The Pennsylvania State University. Programs leading to the degree of Master of Engineering with a major in engineering science have been approved for Behrend College, the Radnor Center for Graduate Studies, and the Capitol Campus. The M.P.A. program also is available at the Radnor Center. Designation of location of program completion will be noted on the student's transcript.

## CHANGE OF DEGREE OR PROGRAM

A graduate student who has been admitted for work in one major program but wishes to transfer to another should submit a request to the Office of Graduate Student Programs of the Graduate School. The student's credentials will be reviewed and the proposed new major department head or committee chairman consulted. If the change is approved but the student is inadequately prepared for the new major, the student may be required to make up certain undergraduate deficiencies.

A graduate student admitted for either an academic degree (M.A., M.S., or Ph.D.) or a professional degree (M.Adm., M.Agr., M.Arch., M.B.A., M.E.P.C., M.Ed., M.Eng., M.F.A., M.F.R., M.Mus., M.P.A., M.Ps.Sc., M.R.P., or D.Ed.) who wishes to change from one type of degree program to another must apply to the Office of Graduate Student Programs for the transfer. Similarly, a student who has earned a master's degree but wishes to earn a different type of doctoral degree must apply for a formal transfer. A student may be required to make up certain deficiencies if inadequately prepared for the new program.

## GRADUATE CREDITS

It is important that the student understand that in the Graduate School the word "credit" has no meaning other than as a unit of time — time spent in residence and in off-campus graduate work. One credit stands for the equivalent of approximately one week of full-time graduate work, and 10 credits for a term's work.

Typically, a candidate for an advanced degree is required to earn a certain minimum number of credits at The Pennsylvania State University. Consequently, there is a limit to the number of credits which may be earned at another approved institution or through continuing education to meet the minimum requirements of the degree. Moreover, the department or committee in charge of a major program may require a student to do more of the work at the University than specified by the limitations set by the Graduate Faculty. The normal credit load of a full-time graduate student is 8 to 10 credits per term, or the equivalent (see Academic Credit and Employment, page 71).

Graduate courses carry numbers from 500 to 599. Advanced undergraduate courses numbered between 400 and 499 may be used to meet some graduate degree requirements when taken by graduate students.

**CONTINUING EDUCATION** — A large number of courses carrying credit are given throughout the Commonwealth of Pennsylvania through continuing education. All 400-series courses so offered *may* be used to meet graduate degree requirements when taken by students who have been admitted to the Graduate School. The graduate adviser's signature is required on the official registration form, which the student submits at the designated place of registration for the course.

There is no limit to the number of credits which a student may earn in continuing education, but not more than 10 credits in 400-level courses so earned may be applied toward the minimum requirements for an advanced degree.



## REGISTRATION

The responsibility for being properly registered rests with the student. The student is expected to register each term, for either course work or research toward the thesis, whether it be on or off campus. In the case of research, the number of credits shall be determined by the amount of time required for the investigation, 1 credit representing the equivalent of one week of full-time work. In the later stages of the program the situation will determine the requirements for the student's registration. (See below, **REGISTRATION NEAR THE COMPLETION OF A PROGRAM.**)

**ADVISERS** — To assist the student in planning a program, the head of the major department or program chairman will designate a member of the faculty to serve as adviser. It is the student's responsibility to secure the name of an adviser from the department head and to seek a conference before registration.

**TIME OF REGISTRATION** — Registration days are indicated in the calendar at the beginning of this bulletin.

A student is expected to complete registration during the officially designated period and to attend the first meeting of all classes. If this is impossible because of some emergency or unusual circumstance, the student may be granted permission by the instructor to miss a few class meetings, it being understood that work missed will be made up subsequently. Under these conditions permission may be granted through the Office of Graduate Student Programs for the student to register late. In general, a student who receives permission to register late will be required to reduce the course load in proportion to the length of the absence.

A student who fails to complete the process of registration within the officially designated registration period will be liable for the late registration charge, regardless of when the student begins attending classes.

**CONTINUITY OF REGISTRATION** — A student who registers at University Park without interruption for each of the three terms in the September-to-June interval, for all four terms each year, or for summer terms only is considered to have maintained a normal continuity of registration.

Anyone who has interrupted such a normal sequence and now plans to register for work at the University Park Campus is required to apply to the Office of Graduate Student Programs, 211 Kern Graduate Building, at least one month before the time of registration, for permission to resume study.

The policy may be summarized for any specific term as follows:

**Summer Term** — Application required unless the student was registered at University Park for the preceding spring term or the preceding summer term.

**Fall Term** — Application required unless the student was registered at University Park for the preceding summer term or the preceding spring term.

**Winter Term** — Application required unless the student was registered at University Park for the preceding fall term.

**Spring Term** — Application required unless the student was registered at University Park for the preceding winter term.

**PROCEDURE** — For each registration the student, in consultation with the adviser, prepares a schedule of courses and research designed to fit individual needs. The credit load will be reviewed at the time of registration. The registration process is completed in the manner specified for all students at the University.

Under certain conditions credit may be earned for work done away from the campus. A student contemplating such work should inquire at the Office of Graduate Student Programs about the procedures and conditions. The student must assume responsibility for the registration process, but the operation can be handled by mail. Registration must be completed before the close of central registration at University Park.

A student must register for courses audited as well as for those taken for credit.

**REGISTRATION NEAR THE COMPLETION OF A PROGRAM** — A candidate for the Ph.D. degree is required to register continuously (at least three terms of each four) from the time the comprehensive examination is passed and the three-term residence requirement is met until the thesis is accepted by the doctoral committee, regardless of whether work is being done on the thesis during this interval.

D.Ed. degree candidates and master's students may be required to register for a normal credit load because of their appointment status. If not, and if they have earned more than 90 (D.Ed.) or 30 (master's) credits and have met the requirements for their degrees except for the completion of the thesis, these students may register for as few as 2 credits per term. A student, other than the Ph.D. degree candidate, who has met the minimum requirements for a degree and is now completing research and thesis writing off campus is not required to register, even if visits are made to the campus several times each term to see an adviser, unless required to do so within the program.

A student, other than one following the Ph.D. requirement, is not required to register for the final term in order to graduate or in order to make minor revision to the thesis and/or to take a final examination for the degree, unless required to do so by the program.

**VISITING AND AUDITING CLASSES** — A graduate student registered for a given term who wishes to attend classes without receiving credit may secure permission either to visit or to audit courses during that term.

As a visitor, a student may attend classes with the approval of the instructor but may not claim the usual privileges of class membership, such as participating in discussion, doing practicum work, or taking examinations. Registration is not required for the privilege of visiting, and no record appears on the student's transcript.

As an auditor, a student may participate in class discussion, do practicum work, take examinations, and generally enjoy the privileges of a class member. Registration procedures and fee payment are the same as for taking the course for credit. No credit is given, either on completion of the course or at a later time; however, the number of credits assigned to the course appears on the grade report and on the student's transcript. Thus, when a student receives an audit grade, the number of credits audited is shown. The symbol Au shall be used if attendance has been regular, the symbol W if attendance has been unsatisfactory.

A graduate assistant or fellow, who is required to register for a certain minimum number of credits, is not permitted to count audited course credits toward the minimum credits needed. The 1G and 2G language courses are an exception. The student may register for credit or audit beyond the required minimum but may not exceed the normal maximum without special permission.

In general, students are encouraged to visit classes rather than to register for a course as auditors. However, visiting is not permitted in German 1G and 2G.

In the 1G and 2G courses offered by the language departments, no distinction is made between registering for credit and for audit in considering loads.

**THESIS RESEARCH** — In registering for thesis research a student uses the appropriate number (600, 610) preceded by the abbreviation designating the major field. The numbers 600 (on campus) and 610 (off campus) are available for credit in thesis research in all graduate major programs.

**THESIS PREPARATION** — The numbers 601 and 611 are available to Ph.D. degree candidates and are used for special noncredit registration for thesis preparation work. Such candidates must have passed the comprehensive examination and must have met the three-term residence requirement. A candidate registered for SUBJ. 601 is classified as a full-time student, while one registered for SUBJ. 611 is classified as a part-time student.

The numbers 600, 601, 610, and 611 may not always appear in the *Schedule of Classes* for each term.

**COMMON COURSES** — The following courses for which students may register have been set up for common use by major programs, with University Senate approval, to encourage innovation and provide flexibility in designing graduate programs:

590. **COLLOQUIUM (1-3)** Continuing seminars which consist of a series of individual lectures by faculty, students, or outside speakers.

596. **INDIVIDUAL STUDIES (1-6)** Creative projects, including nonthesis research, which are supervised on an individual basis and which fall outside the scope of formal courses. A specific title may be used in each instance and will be entered on the student's transcript. Multiple offerings may be accommodated by the use of suffixes a, b, etc.

597. **SPECIAL TOPICS (1-6)** Formal courses given on a topical or special interest subject which may be offered infrequently; several different topics may be taught in one year or term. A specific title may



be used in each instance and will be entered on the student's transcript. Multiple offerings may be accommodated by the use of suffixes a, b, etc.

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6) May be offered by any graduate program in a department which also offers undergraduate courses. A graduate program with no counterpart undergraduate program may offer SUBJ. 602 when cooperative arrangements are made with an administrative unit which does not offer graduate degrees but which uses graduate assistants in its teaching. SUBJ. 602 may be offered in any term and is subject to the following restrictions:

1. SUBJ. 602 shall not be counted in fulfilling any specific credit requirement for an advanced degree.
2. SUBJ. 602 shall be graded (A, B, C, D, F).
3. SUBJ. 602 shall not be used in calculating grade-point averages.
4. SUBJ. 602 shall be offered only in those graduate programs wishing to provide opportunity for supervised and graded teaching experience. Enrollment shall be restricted to students for whom the major program is prepared to provide such experience.
5. SUBJ. 602 may, but need not, be counted as a part of the normal credit load for graduate assistants.

## ACADEMIC CREDIT AND EMPLOYMENT

To provide flexibility in arranging credit loads for graduate assistants and full-time University staff members, a procedure has been set up whereby the normal credit limits may be changed by permission of the person to whom the student or staff member is responsible for University employment or assistantship assignment. Maintenance of the established credit loads and responsibility for the consequences of a graduate student's change of course load rests with the student and adviser. The course load is a factor in determining whether a graduate student is classified as a full-time or part-time student; has met residence requirements; and is eligible to hold a fellowship, scholarship, assistantship, or departmental or program appointment. Students holding fellowships, traineeships, or other awards based on academic excellence are commonly required to carry 8 or more credits each term.

The University takes the position that the facilities of the Graduate School should be made available first to students who can profit from their graduate school experience to the maximum extent. More than doing what is required in courses or in research, the graduate experience is one of living in a scholarly atmosphere and seriously engaging in scholarly pursuits. It means profiting from hearing visiting scholars and artists and from engaging in discussions, both formal and informal, with faculty members and fellow students. It is an involvement and participation in student affairs, University and Graduate School governance, committee assignments, and personal contribution of effort to the welfare and betterment of the University graduate community. It should mean leisure time for reflection and for exploring fields related to, although not directly a part of, one's specialty. Students who propose schedules of few credits not requiring serious effort, or those who wish to carry overloads of such proportion as to handicap them seriously in achieving maximum quality, find it difficult and often impossible to experience the satisfaction of a well-rounded scholarly attainment.

A graduate student should achieve a balance between academic credit load, employment, and appointment responsibilities which results in classification as a full-time graduate student with all the privileges and responsibilities intrinsic to this classification. The student's full-time classification is certified by the department head or program chairman and is sent to the Office of Graduate Student Programs.\*

**FULL-TIME ACADEMIC STATUS** — In establishing credit loads, a student who in any term is registered for 8 or more credits *or* who holds a quarter-time assistantship and schedules 7 credits *or* who has a half-time assistantship and schedules 5-7 credits is considered to be engaged in full-time academic work for that term.

\*Full-time University employees and three-quarter-time graduate assistants may meet Ph.D. degree residence requirements by registering for the full number of credits allowable (4 credits per term for full-time University employees, 4-5 credits for three-quarter-time assistants) and by obtaining certification from the department head as being principally engaged in activities relating to their academic programs.

**PART-TIME ACADEMIC STATUS** — A student who in any term is registered for fewer than 8 credits and does not hold a half-time or quarter-time assistantship is considered to be engaged in part-time academic work for that term.

**FULL-TIME EMPLOYMENT OFF CAMPUS** — A candidate for the Ph.D. degree may not count the work of any term toward the residence requirement for this degree while engaged in full-time employment off campus.

**BENEFITS AND PRIVILEGES** — A student registered for 6 or more credits of course work *or* for noncredit SUBJ. 601 *or* who holds a half-time assistantship and is carrying at least 5 credits is entitled to the *nonacademic* student benefits and privileges of a full-time student.

**STAFF EMPLOYEE CREDIT STATUS\*** — A full-time staff employee of the University may schedule 4 credits per term (up to 16 credits per academic year), either for credit or audit.

No member of the faculty in one of the professorial ranks in the University may receive the master's degree or the doctoral degree from the University.

For University staff employees desiring to take graduate degree work, admission to the Graduate School is a first essential.

**EMPLOYMENT** — Many students depend upon part-time employment to help meet their expenses. A student who is thus employed, whether on campus or off campus, must recognize the time demands of a work schedule in planning an academic program. A student holding a fellowship or scholarship may not accept employment of any kind for service beyond that specifically permitted by the appointment. Graduate assistants may accept concurrent employment outside the University only after obtaining permission from the head of the department providing the assistantship and from the person in charge of the assistant's graduate program. A graduate assistant may not hold a concurrent appointment with the University other than a Fellowship Supplement.

**COURSE-NUMBERING SYSTEM** — Courses in the series 1-399 are not listed in this catalog because they are strictly undergraduate and yield no graduate credit. A graduate student may register for or audit these courses in order to make up deficiencies or to fill in gaps in previous education but not to meet requirements for an advanced degree.

Courses in the series 400-499 are for upperclass students with at least junior standing and for graduate students. Only a limited number of credits earned in these courses may be counted toward the requirements for an advanced degree. Detailed regulations concerning the restrictions are given on pages 79-86 under the specific requirements for the various master's degrees.

Courses in the series 500-599 are restricted to students registered in the Graduate School, seniors with an average of at least 3.50, and other students who have been granted permission to enroll through the Office of Graduate Student Programs.

The numbers 600 (on campus) and 610 (off campus) are available for credit in thesis research in all graduate major programs. The numbers 601 and 611 do not denote courses but are used for noncredit special registration for thesis preparation by a Ph.D. candidate. Registration under these numbers will maintain status as a student during the interval which begins at the time the student passes the comprehensive examination and meets the three-term residence requirement and ends at the time the doctoral committee accepts the thesis. The student will register for 601 if engaged full time in the preparation of a thesis, or will register for 611 if engaged only part time in thesis preparation. Candidates for the Ph.D. degree do not receive grades for noncredit registrations (601 and 611).

**SCHEDULE OF COURSES** — A complete list of the courses which will be offered in any specific term is given in the *Schedule of Classes*, which is available at nominal cost from the Scheduling Office approximately four months before the beginning of the term. It gives the number of credits being offered in each course, the hours at which the class will meet, the location of the class, and in some cases the instructor's name.

\*Full-time University employees and three-quarter-time graduate assistants may meet Ph.D. degree residence requirements by registering for the full number of credits allowable (4 credits per term for full-time University employees, 4-5 credits for three-quarter-time assistants) and by obtaining certification from the department head as being principally engaged in activities relating to their academic programs.



## GRADING SYSTEM

A grade is given solely on the basis of the instructor's judgment as to the student's scholarly attainment.

The following grading system is in effect: Any one of five quality grades (A,B,C,D,F) may be given a graduate student for course work or for thesis research. The grade-point equivalents are 4.00, 3.00, 2.00, 1.00, 0, respectively.

At the 400, 500, and 600 levels, grades of A, B, and C denote graduate credit, whereas D and F are failing grades for graduate students, D being the normal failing grade. A grade of F indicates doubt in the judgment of the instructor of the student's potential for further graduate study.

A minimum grade-point average of 3.00 for work done at the University is required for graduation.

In addition to the quality grades listed above, two symbols, Def. (deferred) and R, may appear on a student's transcript. If work is incomplete at the end of a term for a reason beyond the student's control, or if very little work remains to be done, the instructor may report Def. in place of a grade, which will appear temporarily on the student's record. The deferral must be removed within six weeks of the beginning of the succeeding term, unless a special extension is granted by the associate dean of the Office of Graduate Student Programs. If the work is completed within the specified period of deferral, and the instructor does not report a passing grade, the graduate recorder automatically records a failing grade after duly notifying the department head or program chairman to that effect. No student may be approved for a degree while a grade deferral for a required course remains on the record. Deferred grade cards may be obtained from the graduate recorder, 112 Shields Building.

In the case of thesis work, either in progress or completed, and certain courses approved by the University Senate, the instructor may report the symbol R in place of a grade. This symbol indicates that the student has devoted an adequate amount of time to the work scheduled but gives no indication of its quality. When reported for thesis work, this symbol will not influence the grade-point average and remains on the student's transcript permanently if not converted to a quality grade (A, B, C, D, or F) within one term of its recording. Quality grades reported for a given term for thesis work will be included in the cumulative grade-point average. Quality grades reported for research will not apply to R's given for earlier registrations and will not denote the quality of an entire series of R's. It is expected that an R grade for a course will be changed to a quality grade when the work for that course has been completed. Ordinarily, a quality grade will be reported no later than the end of the following term.

## UNSATISFACTORY SCHOLARSHIP

A graduate student who fails to maintain satisfactory scholarship or to make acceptable progress in a degree program will be dropped from the University. A cumulative grade-point average below 3.00 for any term or terms may be considered as evidence of failure to maintain satisfactory scholarship. Action may be initiated by the department or committee in charge of the graduate major or by the chairman of the student's doctoral committee.

## GRADUATION

It is the responsibility of the student to inform the graduate recorder of intention to graduate (by filing a diploma card) and to pay the thesis fee at the beginning of the term in which an advanced degree is expected to be received. If the student does not graduate, the diploma card must be reactivated during the actual term of graduation. Deadlines are given in the calendar found at the beginning of this bulletin.

A preliminary graduation list is prepared by the graduate recorder soon after the deadline for each term. Transcripts are prepared and checked in the offices of the Graduate School and the recorder. The records of candidates who appear to have met requirements are forwarded to major and minor department heads or program chairmen for review and recommendation. The final list of approved candidates appears in the commencement program.

Only those transfer credits which have been accepted by the Graduate School and entered upon the student's transcript by the recorder before the graduate list deadline will be considered in evaluating a student for graduation at the end of that particular term.

Attendance at commencement exercises is expected, but forms for permission to receive the degree in absentia are available in the Office of Graduate Student Programs in 211 Kern Graduate Building and in the Office of Graduate Records in 112 Shields Building. The form must be completed and filed with the graduate recorder by the date specified in the graduate calendar.

All degrees conferred are tentative until final grade reports have been received and all requirements fulfilled, even though the student's name may have appeared in the commencement program. A student's transcript or diploma, or both, may be withheld until any outstanding financial obligations to the University have been paid.

## DOCTORAL DEGREES

The Doctor of Philosophy, an academic degree, and the Doctor of Education, a professional degree, are conferred by the University. Recognized as different in purpose, the two programs consequently have different requirements in certain respects.

### ADMISSION

A student who has been admitted to the Graduate School and has been accepted by the department or committee in charge of a major program in which the doctorate is offered may begin working toward a doctoral degree. However, the student has no official status as a doctoral student and no assurance of acceptance as a doctoral candidate until the candidacy examination has been passed. This examination is administered by the major department or graduate program and is given early in the student's program.

It is the policy of the Graduate School not to permit applicants to work for a second doctoral degree. The President, on recommendation of the dean of the Graduate School, will welcome, as guests, holders of earned doctoral degrees who may be visiting the University Park Campus for purposes of noncredit study. Guest privileges apply to persons holding the degree from The Pennsylvania State University or other accredited colleges and universities. Guests may attend seminars and courses and, if space and facilities are available, carry on research. There will be no charge except for laboratory expenses. Arrangements should be made in advance with the dean of the Graduate School.

### GENERAL REQUIREMENTS

No specified number of courses completed or credits earned will assure attainment of the doctorate. The general requirements are based upon a period of residence, the writing of a satisfactory thesis, and the passing of a comprehensive and a final oral examination. A doctoral program consists of such a combination of courses, seminars, and individual study and research as meets the minimum requirements of the Graduate School and is approved by the doctoral committee for each individual student.

A master's degree is not a prerequisite for the doctorate in some major programs. However, the first year of graduate study leading to the Ph.D. may be substantially the same as that provided for the M.A. or M.S. degree. Similarly, the first year of the D.Ed. program may be essentially the same as that provided for the M.Ed. degree.

### GRADE-POINT AVERAGE

A minimum grade-point average of 3.00 for work done at the University is required for admission to the comprehensive examination and for graduation.

### TIME LIMITATION

A student is required to complete the program within seven years from the date of acceptance as a candidate.

### OFF-CAMPUS AND TRANSFER CREDITS

Subject to the approval of the adviser and the head of the major department or program chairman, a student may register for research to be done away from the University Park Campus.

A maximum of 30 credits beyond the baccalaureate at an accredited school not granting the doctorate in the student's major program may be accepted by the Graduate School in partial fulfillment of the re-



quirements for a doctoral degree at The Pennsylvania State University. A maximum of two full academic years of work (60 credits) beyond the baccalaureate at an accredited graduate school which grants the doctorate in the candidate's major program may be accepted here to apply toward doctoral degree requirements. Advanced standing is awarded for only one master's degree. Academic work to be so transferred must meet the following criteria: (1) It must have been completed within five years prior to the date of admission to the Graduate School of The Pennsylvania State University; (2) it must appear on an official graduate transcript; (3) it must be of at least B quality; and (4) it must be deemed applicable to the student's program by the current academic adviser, approved in writing, and submitted to the Graduate School assistant director of admissions for approval and action. Credit earned externally in postbaccalaureate professional degree programs (law, medicine, etc.) is not transferable.

The following caveat should be noted. Pass-fail grades are not transferable to an advanced degree program unless the "pass" can be substantiated by the former institution as having at least B quality.

A completed master's degree may be transferred to a doctoral program with no intervening time limitation.

## ADVISERS AND DOCTORAL COMMITTEES

Following admittance to a degree program, the student should confer with the head of that major department or program concerning procedures and the appointment of an adviser. Arrangement and approval of the details of the student's term-by-term schedule is the function of the adviser. This person may be a member of the doctoral committee or someone else designated by the head of the major program for this specific duty.

General guidance of a doctoral candidate is the responsibility of a doctoral committee consisting of four or more members of the Graduate Faculty. One member shall be from outside the candidate's major program. (For the D.Ed. doctoral committee, this committee member must be a faculty member in the candidate's minor field or general studies area — *See MAJOR PROGRAM AND MINOR FIELD under D.Ed. — ADDITIONAL SPECIFIC REQUIREMENTS.*) This committee is appointed through the Office of Graduate Student Programs, upon recommendation of the head of the major program, after the student is admitted to candidacy. At the discretion of the associate dean, other members may be added to the committee. The supervisor of the candidate's thesis will usually, but not necessarily, be designated as chairman. The chairman, with the following exception, must hold senior membership in the Graduate Faculty. An associate member may supervise the research for a doctoral candidate.

The doctoral committee is responsible for establishing the broad outline of the student's program and should review the program as soon as possible after the student's admission to candidacy. It will prepare, give, and evaluate the candidate's examinations, and supervise and approve the thesis. A favorable vote of at least two-thirds of the members of the committee is required for passing a comprehensive or a final oral examination. If a candidate fails an examination, it is the responsibility of the doctoral committee to determine whether another examination may be taken.

The committee will also notify the associate dean when the candidate is ready to have the comprehensive and the final oral examinations scheduled and will report the results of these examinations to the Office of Graduate Student Programs.

## COMMUNICATION AND FOREIGN LANGUAGE COMPETENCE

A candidate for the degree of Doctor of Philosophy is required to demonstrate high-level competence in the use of the English language, including reading, writing, listening, and speaking. Proficiency is expected at the time of admission to the Graduate School or must be achieved before admission to candidacy.

In addition to demonstrating competence in English, each candidate for the Ph.D. must meet any communication and foreign language requirements which have been established within the major program. The candidate should ascertain specific language requirements by contacting the professor in charge of the program, whose name appears with the program description under **GRADUATE MAJOR PROGRAMS AND COURSES**.

If a candidate is to be examined for knowledge of a foreign language other than French or Spanish, the intention to take the examination must be reported to the secretary of the language department by the

end of the first week of classes for the term during which the examination is to be taken. This date is one week prior to the examination date. This written examination will be administered on dates announced for each term in the graduate calendar at the beginning of this bulletin.

The Pennsylvania State University has been named by Educational Testing Service as a testing center for the administration of the written tests for students to be examined in French or Spanish. Students wishing to make application to take these tests should, at their earliest convenience, check with the Office of Examination Services, 207 Mitchell Building, University Park, PA 16802. A test fee of \$12 is payable at the time of application. Times and places of tests will be given when the test application is filed.

Candidates for the Doctor of Education degree may be required to demonstrate competence in foreign languages.

## CANDIDACY EXAMINATION

The candidacy examination is administered by the Graduate Faculty in the graduate major program and should be taken early in the student's program. The nature of the examination varies with the program and may be the master's examination if so allowed. The decision to admit or not to admit a student to candidacy must be made by the Graduate Faculty or a designated committee of Graduate Faculty. For the Ph.D. student the examination may be given after at least 12 credits have been earned in graduate courses beyond the baccalaureate. The examination must be taken within three terms after having earned 24 credits.

For the D.Ed. student, the examination should be given when the student has earned a total of approximately 30 credits, including the master's program and work done elsewhere. A student transferring from another graduate school with 30 or more transfer credits must take the candidacy examination prior to earning more than 10 credits here.

## COMPREHENSIVE EXAMINATION

When a candidate for the Ph.D. or D.Ed. degree has substantially completed the course work, a comprehensive examination covering the major program and minor field of study is required.

A candidate for the Ph.D. must have satisfied the communication and foreign language requirement before taking the examination.

All candidates are required to have a minimum grade-point average of 3.00 for work done at the University at the time the comprehensive examination is given.

The examination is officially scheduled and announced by the associate dean for graduate student programs upon recommendation of the doctoral committee. It is given and evaluated by the doctoral committee and may be *either written or oral, or both*. A favorable vote of at least two-thirds of the members of the committee is required for passing. In case of failure it is the responsibility of the doctoral committee to determine whether the candidate may take another examination. The results are reported to the Office of Graduate Student Programs and will be entered on the candidate's official record.

When a period of more than five years has elapsed between the passing of the comprehensive examination and the completion of the program, the student is required to pass a second comprehensive examination before the final oral examination will be scheduled.

## FINAL ORAL EXAMINATION

The doctoral candidate who has satisfied all other requirements for the degree will be scheduled by the associate dean for graduate student programs, on the recommendation of the doctoral committee, to take a final examination. Normally the final oral examination may not be scheduled until at least three months have elapsed after the comprehensive examination was passed, although the associate dean may grant a waiver in the case of an outstanding student. The deadline for holding the examination is seven weeks before commencement. It is the responsibility of the doctoral candidate to provide a copy of the thesis to each member of the doctoral committee at least one week before the date of the scheduled examination.

The final examination is oral, open to the public, and related in large part to the thesis; but it may cover the candidate's whole program of study without regard to courses that have been taken either here or elsewhere.



A favorable vote of at least two-thirds of the members of the committee is required for passing. The results of the examination are reported to the Office of Graduate Student Programs and will be entered upon the candidate's official record. If a candidate fails, it is the responsibility of the doctoral committee to determine whether another examination may be taken.

## Ph.D. — ADDITIONAL SPECIFIC REQUIREMENTS

The degree of Doctor of Philosophy is conferred in recognition of high attainment and productive scholarship in some special field of learning as evidenced by (1) the satisfactory completion of a prescribed period of study and investigation; (2) the preparation of a thesis involving independent research; and (3) the successful passing of examinations covering both the special subject and the general field of learning of which this subject forms a part.

### RESIDENCE REQUIREMENTS

There is no required minimum of credits or terms of study, but over some twelve-month period during the interval between admission to candidacy and completion of the Ph.D. program the candidate must spend at least three terms (which may include the term in which the candidacy examination is taken) as a registered full-time student engaged in academic work on the University Park Campus or at The Milton S. Hershey Medical Center. Full-time University employees must be certified by the department as devoting half time or more to graduate studies and/or thesis research to meet the degree requirements (see Academic Credit and Employment, page 71).

### CONTINUOUS REGISTRATION

After a student has passed the comprehensive examination *and* met the three-term residence requirement, no further registration for credit will be required by the Graduate School. However, status as a student must be maintained by registering continuously (at least three terms of each four, beginning with the first term after both of the requirements mentioned above have been met) until the thesis is accepted by the doctoral committee. This registration may be for (1) noncredit 601 or 611 only, with payment of the special thesis preparation fee; (2) noncredit 601 or 611 with payment of the special thesis preparation fee plus course registration at the regular per credit fee; or (3) full-time course credits with payment of the regular tuition fee. Grades are not given for noncredit 601 or 611. Failure to maintain registration will result in termination of student status.

### MINOR FIELD

A Ph.D. candidate is not required by the Graduate Faculty to have a minor field of study. However, a department or a committee in charge of a major field may require a candidate to offer work in a minor field, or a student may elect such a program with the permission of the doctoral committee.

A minor consists of no fewer than 15 credits, including those applied toward the master's degree, of integrated or articulated work in one field related to, but different from, that of the major. A minor program must meet the approval of the departments or committees responsible for both the major program and the minor field.

### THESIS

The ability to do independent research and competence in scholarly exposition must be demonstrated by the preparation of a thesis on some topic related to the major subject. It should represent a significant contribution to knowledge, be presented in a scholarly manner, reveal an ability on the part of the candidate to do independent research of high quality, and indicate considerable experience in using a variety of research techniques. The contents and conclusions of the thesis must be defended at the time of the final oral examination.

The completed thesis must be submitted to the Office of Theses and Publications not later than five weeks prior to the commencement at which the candidate expects to receive the degree.

A *Thesis Information Bulletin*, which gives details concerning format, paper, typing, and other requirements, may be obtained at the Graduate School Office of Theses and Publications, 320 Kern Graduate Building. Following editorial review of the thesis by this office, it is expected that the student will submit a copy of the thesis, incorporating format corrections, to the office of the department or program head.

## D.Ed. — ADDITIONAL SPECIFIC REQUIREMENTS

Programs leading to the degree of Doctor of Education are not limited to specific fields of education but, with the consent of the department or committee in charge and concurrence by the dean of the College of Education, may also be offered in any other field appropriate to the preparation of professional educators which has been approved for the doctorate.

The degree is conferred in recognition of advanced preparation of a high order for work in the profession of education as evidenced by (1) satisfactory completion of a prescribed period of study; (2) ability to apply scientific principles to practitioner problems in a variety of education endeavors; (3) preparation of a thesis demonstrating ability to undertake an educational problem with originality and independent thought; and (4) successful performance on major and minor examinations, showing a satisfactory grasp of the field of specialization and its relation to allied education areas.

### RESIDENCE REQUIREMENTS

A minimum of nine terms of full-time graduate study and research (10 credits per term), or their equivalent in credits (90 credits), of which at least 30 credits must be earned in residence, is required for the D.Ed. degree. The D.Ed. candidate may meet the requirements by attending summer terms unless the major department requires a period of registration in other terms or in consecutive terms at University Park. A candidate may register for a maximum of 30 credits of research in absentia, but none of these may count toward the minimum of 30 credits which must be earned at the University Park Campus. It is expected that students will register for a minimum of 15 credits of thesis research. The maximum credit load permitted a student who is employed full time is 4 credits per term.

### MAJOR PROGRAM AND MINOR FIELD

The program of study includes a major and either a minor or a group of general studies. A majority of the courses offered in fulfillment of the requirements must be in the major program of study.

A candidate choosing a major outside the field of education (such as history) shall have a minor consisting of no fewer than 15 credits in education, including those applied toward the master's degree, as recommended to the dean of the Graduate School early in the major program with the approval of a faculty adviser designated by the dean of the College of Education.

A candidate choosing a major in one of the approved programs in education must also choose either a minor or a group of general studies with the approval of the major program chairman. In this case a minor consists of no fewer than 15 credits, including those applied toward the master's degree, in one field outside those of education. An acceptable general studies group consists of no fewer than 15 credits, including those applied toward the master's degree, in fields outside those of education considered by the major program committee to have significance and value for the candidate.

### COMPREHENSIVE EXAMINATION

In addition to demonstrating a high level of competence in the subject matter in the major program and minor field, each candidate must show, by a comprehensive examination, an understanding of current theories of education and the ability to apply the techniques and findings of educational research so far as they bear upon the teaching of the subject matter. The candidate must also be able to understand and contribute to the technical and professional literature in the field, and to criticize learned procedures in the light of historical trends and practices in this and other countries. Command of the tools for a thorough study of the problems of education is necessary and must include competence in the use of statis-



tical methods. For certain students the requirements may include a reading knowledge of one or more foreign languages.

All candidates are required to have a minimum grade-point average of 3.00 for academic work done at the University at the time the comprehensive examination is given.

## THESIS

Evidence of a high degree of scholarship, competence in scholarly exposition, and ability to select, organize, and apply knowledge must be presented by the candidate in the form of a written thesis. The candidate must demonstrate a capacity for independent thought, as well as ability and originality in the application of educational principles or in the development of new generalizations under scientific controls. A thesis may be based upon a product or project of a professional nature, provided scholarly research is involved. For example, it may be based upon the solution of a professional problem concerned with the development of a curriculum, or a product of creative effort related to education. However, in order to be acceptable as a thesis, the professional project must be accompanied by a written discourse demonstrating the nature of the research and including such theories, experiments, and other rational processes as were used in effecting the final result. The topic and outline of the proposed thesis must have the approval of the doctoral committee.

The completed thesis must be submitted to the Office of Theses and Publications not later than five weeks prior to the commencement at which the candidate expects to receive the degree.

A *Thesis Information Bulletin*, which gives details concerning format, paper, typing, and other requirements, may be obtained at the Graduate School Office of Theses and Publications, 320 Kern Graduate Building. Following editorial review of the thesis by this office, it is expected that the student will submit a copy of the thesis, incorporating format corrections, to the office of the department or program head.

## MASTER'S DEGREES

The Graduate School recognizes a difference in purpose, which is reflected in the requirements, for two types of advanced degrees, academic and professional. Of the fifteen master's degrees conferred, the Master of Arts and Master of Science are academic in nature. The professional degrees conferred are Master of Administration, Master of Agriculture, Master of Architecture, Master of Business Administration, Master of Education, Master of Engineering, Master of Environmental Pollution Control, Master of Fine Arts, Master of Forest Resources, Master of Music, Master of Psychosocial Science, Master of Public Administration, and Master of Regional Planning.

A degree is not conferred for a mere collection of credits. A well-balanced, unified, and complete program of study will be required, which may frequently exceed the minimum requirements as specified below under Additional Specific Requirements.

A student may meet the degree requirements by either full-time or part-time enrollment and by attendance in any combination of terms. The student who interrupts the continuity of registration faces the possibility of not being granted permission to return.

## GRADE-POINT AVERAGE

A minimum grade-point average of 3.00 for work done at the University is required for graduation.

## TIME LIMITATION

All requirements for a master's degree, whether satisfied on the University Park Campus or elsewhere, must be met within six years or a period spanning seven consecutive summers.

## ADMISSION

In addition to the general University requirements for admission set forth at the beginning of this bulletin, adequate undergraduate preparation is required in the program in which the applicant expects to

pursue advanced work. The specific courses and the total number of undergraduate credits required in various areas will be determined by the choice of program and can be ascertained from the descriptive statement appearing under the major program heading in the latter portion of this bulletin. An applicant who meets the necessary grade-point average but is deficient in course preparation may, under certain circumstances, be admitted to the Graduate School and be allowed to make up the undergraduate deficiencies. Under these circumstances the program will require more than the necessary period of residence. An applicant for admission to the M.Ed. program in most major programs is required to have had at least 18 credits in education and related psychology, and in certain major programs may be required to have had practice teaching.

After admission to a degree program, a student should confer with the head of the major department or program concerning the appointment of an adviser. The general guidance of a master's candidate is the responsibility of an adviser, or of a committee appointed in a manner to be determined by the major department or program in which the student is specializing. The adviser or the committee assists the student in planning a program of study. Although the adviser is frequently the supervisor of the thesis, this is not necessarily the case.

Requirements concerning courses, language proficiency, minors, comprehensive examinations, and other matters are sometimes made by departments or programs in addition to (but not in conflict with) the regulations of the Graduate School. For details the student should consult the head of the major department or program.

## TRANSFER CREDIT

Subject to the limitations given, a maximum of 10 credits of high-quality graduate work done at another institution may be applied toward the requirements for the master's degree. However, credits earned to complete a previous master's degree may not be applied to a second master's degree program at The Pennsylvania State University.

The student should distinguish carefully between the transferability of credit and its applicability in a particular degree program. Approval to apply any transferred credits toward a degree program must be granted by the student's academic adviser, and the adviser must notify the Graduate School director of admissions, in writing, when such approval is granted. Transferred academic work must have been completed within five years prior to the date of admission to the Graduate School of The Pennsylvania State University, must be of at least B quality, and must appear on a graduate transcript. Credit earned externally in postbaccalaureate professional degree programs (law, medicine, etc.) is not transferable.

Pass-fail grades are not transferable to an advanced degree program unless the "Pass" can be substantiated by the former institution as having at least B quality.

Forms for transfer of credit may be obtained from the Office of Graduate Admissions, 201 Kern Graduate Building.

## EXAMINATIONS

A candidate may be required to pass in a satisfactory manner written or oral examinations designated by the program head. A candidate should consult the major department or program for special requirements.

Examinations to establish credit for work done in absentia or without formal class work may be used to remove undergraduate deficiencies, but *not* to earn credits toward an advanced degree. Arrangements are made by the student directly with the major department head or program chairman.

Graduate Record Examinations are designed to test information and abilities in basic fields of knowledge. Provisions are made on the campus for administering these examinations at scheduled times and upon request of students or department program chairmen. Informational materials may be obtained at the Graduate School Information Center on the first floor of Kern Graduate Building.



## M.A. and M.S. — ADDITIONAL SPECIFIC REQUIREMENTS

The Master of Arts and the Master of Science degrees have similar requirements, the general major area determining which degree is conferred. Programs for both degrees are strongly oriented toward research.

A minimum of 30 graduate credits is required, of which at least 20 must be earned at an established graduate campus of the University. Some graduate programs require additional credits; the exact number can be determined by consulting the specific program description in the subsequent section GRADUATE MAJOR PROGRAMS AND COURSES. A minor is not required of all candidates for the M.A. or M.S. degree. A department or committee in charge of a major program may require a candidate to offer work in a minor field, or the minor may be elected with the permission of the student's committee.

A minor consists of no fewer than 6 credits of integrated or articulated work in one field related to, but different from, that of the major. A minor program must meet the approval of the departments or committees responsible for both the major program and minor field.

The major department or the committee in charge of the major program is the judge as to the suitability of a field for the minor and of its relevance to the major. The minor field department has the responsibility of accepting or rejecting students, advising on courses to be taken by the candidate in the field, examining the candidate in the area of studies undertaken in the field, and certifying that the minor requirements have been met.

At least 18 credits in the 500 and 600 series, combined, must be included in the program. A minimum of 12 credits in course work (400 and 500 series), as contrasted with research, must be completed in the major program. A thesis is required of many candidates for these degrees. Details are given in the introductory paragraphs under the major program headings in the latter part of this catalog. If a student is required to write a thesis, at least 6 credits in thesis research (600 or 610) must be included in the program. If no thesis is required, at least 18 credits must be in 500-level courses.

A thesis is prepared under the direction of the department or program in which the candidate's major work is taken. Under certain conditions a student may complete the thesis off campus. To do so, satisfactory arrangements must be made in advance with the adviser and the head of the major department or program.

Those candidates who are not required to write a thesis must present a suitable essay or paper. Its nature and extent shall be determined by the major program. The department head or program chairman shall report to the Office of Graduate Student Programs the title, the name of the faculty member under whom the student did the work, and whether the work was considered adequate. The program head may require one or more copies of the essay for the program's library or other files.

Some programs in the field of education offer the M.S. degree but prefer to admit students into the M.Ed. degree program. Other programs which emphasize research prefer to admit only students interested in pursuing the Ph.D. degree.

Requirements for the M.A. degree at the Capitol Campus differ somewhat from the above and are outlined under the major programs in American Studies and Humanities. These programs are available only at the Capitol Campus.

A *Thesis Information Bulletin*, which gives details concerning format, paper, typing, and other requirements, may be obtained at the Graduate School Office of Theses and Publications, 320 Kern Graduate Building. Following editorial review of the thesis by this office, it is expected that the student will submit a copy of the thesis, incorporating format corrections, to the office of the department or program head.

## M.Adm. — ADDITIONAL SPECIFIC REQUIREMENTS

The Master of Administration degree program is offered only at the Capitol Campus. It is intended to meet the professional needs of practicing and potential administrators in the fields of business and engineering. Two options are offered: (1) the business administration option is intended for students who desire to pursue an administrative career in business, industry, or institutions; and (2) the engineering

administration option prepares individuals for management positions in engineering, scientific, and technical organizations. Each student is required to complete a professional paper of the quality, if not the theoretical depth, of a thesis.

A description of the Administration program appears subsequently in this bulletin. Further information can be obtained from the Capitol Campus.

## **M.Agr. — ADDITIONAL SPECIFIC REQUIREMENTS**

The Master of Agriculture is a professional degree. Programs leading to this degree provide opportunities for students to increase their knowledge and competences in the various phases of agriculture. A student, according to individual objectives, may obtain intensive training encompassing a wide spectrum of subject matter area or intensive training in a specialized area. The emphasis of the program is to enable students to develop skill as professional practitioners in the communication of technical knowledge and its application to the solution of current and future technical, economic, and social problems of individuals and groups.

The head of the department or program chairman shall appoint a three-member committee to guide and monitor the candidate's professional development. Members of this committee must represent at least two departments. The chairman of the appointed committee shall serve as the candidate's adviser. The candidate will inform the committee of personal aspirations and background early in the program. The committee will suggest to the student how best to achieve these goals and the standard of professional competence required for the Master of Agriculture degree.

A minimum of 30 graduate credits is required, of which 20 credits must be earned in residence at the University Park Campus. A maximum of 10 credits may be earned in special problem-type courses.

The candidate must present an acceptable paper on a selected professional problem or a report of internship training. Up to 3 graduate credits will be given for an acceptable paper. The candidate may be required to provide one or more copies of the paper for the University.

The candidate's committee shall report, through the department head or program chairman, to the Office of Graduate Student Programs the title of the paper and whether the paper and the candidate's academic performance were considered satisfactory.

## **M.Arch. — ADDITIONAL SPECIFIC REQUIREMENTS**

The Master of Architecture is a professional degree and is planned to provide the depth and breadth of knowledge needed to enter the architectural profession and become a licensed professional architect following the required period of internship. Admission requirements include the equivalent of 39 credits in design-research work and a statement of purpose concerning the professional aims of the candidate. The program is available to candidates holding a B.A. or B.S. degree with a major in architecture or environmental design, or holding other nonprofessional degrees in architecture.

A minimum of 60 graduate credits at the 400 and 500 levels is required, 36 of which must at the 500 level. A minimum of 30 credits must be taken at the University Park Campus. A thesis is optional. If a thesis is written, 6 credits of Arch. 600 must be completed. Professional areas of study include building design and architectural programming.



## **M.B.A. — ADDITIONAL SPECIFIC REQUIREMENTS**

The purpose of the Master of Business Administration degree program is to develop professional managerial knowledge and skills as these are applied to decisions in complex organizations. Teaching focuses upon the techniques, the concepts, and the skills important to modern administrators.

A minimum of 48 graduate credits is required, all at the 500 level. Thirty-six credits must be in specified core courses. Also required are 12 credits in major field courses and electives (including a professional paper). Work for this degree may be started in the fall term only. Applications must include the results of the Graduate Management Admission Test.

## **M.Ed. — ADDITIONAL SPECIFIC REQUIREMENTS**

The programs leading to the degree of Master of Education provide preparation for increased professional competence in education. They should be distinguished carefully from the research-oriented programs which lead to the academic degrees of Master of Arts or Master of Science. In most major programs the requirements for admission include 18 credits in education and related psychology.

A minimum of 30 graduate credits is required for the degree, of which at least 20 must be earned at an established graduate campus of the University; at least 24 must be in course work. This degree is also offered at the Capitol Campus and the Radnor Center for Graduate Studies.

### **MAJOR PROGRAMS IN THE FIELDS OF EDUCATION**

A student may major in one of the approved programs in education, such as curriculum and instruction, educational psychology, or home economics education, and proceed under the guidance of a graduate faculty member in the appropriate major in education. At least 12 of the required credits in course work must be taken at the 500 level.

A program of this type requires at least 6 credits to be earned outside the programs in education, or the 6-credit requirement may be met with course work in the specific fields of educational psychology or educational theory and policy studies.

### **MAJOR PROGRAMS OUTSIDE THE FIELDS OF EDUCATION**

A student who is preparing to teach in a specific subject-matter field, such as economics, mathematics, or German, may choose such a program as a major and take a majority of work in it under the guidance of the department offering that major. A student wishing to study in a broader area may choose a major such as human development and family studies, earth sciences, or extension education and take at least 24 credits in the area under the guidance of the committee in charge of the major.

Each candidate is required to earn 6 credits in education as directed by the faculty of one of the approved graduate programs in education. The 6 credits may be taken in educational foundations, which includes courses in comparative education; history, sociology, and philosophy of education; and educational psychology.

### **THESIS OR PAPER**

Six credits may be granted for an approved thesis. A candidate who does not elect to write a thesis is required to present an essay or paper. It must be of considerable proportion, indicating capacity to describe a serious intellectual experience adequately in writing, and giving unmistakable evidence of ability to formulate and state meaningfully the purpose of an investigation, study, critical analysis, or evaluation; to acquire and analyze information; to draw conclusions logically; and to relate findings to professional problems and practices. The nature and extent of this piece of writing, whether it be required in connection with a course or independent of course work, and when it is to be undertaken shall be determined by the major program. The program chairman shall report to the Office of Graduate Student Programs the title, the name of the faculty member under whom the student did the work, and

whether the work was considered adequate. It is the right, but not the responsibility, of the program chairman to require one or more copies of the essay for the program's library or other files.

## **M.Eng. — ADDITIONAL SPECIFIC REQUIREMENTS**

The programs leading to the degree of Master of Engineering provide training for advanced professional competence in the several fields of engineering. They should be distinguished carefully from the research-oriented programs which lead to the academic degree of Master of Science.

A minimum of 30 graduate credits is required, of which 20 must be earned at an established graduate campus of the University. At least 12 credits must be earned in graduate courses (500 series).

A scholarly written report on a developmental study involving at least one area represented in the candidate's course work is required as an integral part of the program. The report must be comparable in its level of work and quality to a graduate thesis. The topic of the developmental study is subject to prior approval by the department in which the candidate's major work is taken, and preparation of the written report shall be under the direction of that department.

Work for this degree is not required to be done specifically on the University Park Campus. A complete program of study can be pursued at the Capitol Campus, at Behrend College, or at the Radnor Center for Graduate Studies of The Pennsylvania State University.

## **M.E.P.C. — ADDITIONAL SPECIFIC REQUIREMENTS**

The Master of Environmental Pollution Control is an intercollege professional degree designed for students who are interested in pursuing a career in the field of environmental pollution control. Special requirements include 9 credits of core courses covering air and water pollution control and solid waste management and participation in the environmental pollution control seminar program. A minimum of 30 graduate credits is required, 20 of which must be taken at either the University Park Campus or the Capitol Campus. Nine of these 30 credits must be taken at the 500 level; the E.P.C. 590 seminars and any 500-level paper-writing courses may not be counted as part of this 9-credit requirement. A master's paper must be submitted by all M.E.P.C. candidates.

## **M.F.A. — ADDITIONAL SPECIFIC REQUIREMENTS**

The programs leading to the degree of Master of Fine Arts provide training for increased professional competence in the several specialized areas of the arts. They should be distinguished carefully from the research-oriented programs which lead to the academic degree of Master of Arts with a major in art or theatre arts.

A minimum of 48 credits is required, of which at least 38 must be earned at the University Park Campus. The larger part of these credits should be above the 400 level, but the needs of the student shall be considered in arranging the best combination of courses and research for the preparation of the candidate in a particular field.

A professional project, either creative or interpretative, is required. This project shall include a monograph in support of the creative or interpretative aspect of the program; the project and monograph shall represent a minimum of 6 credits on the 600 level.



## **M.F.R. — ADDITIONAL SPECIFIC REQUIREMENTS**

The program leading to the degree of Master of Forest Resources provides training for increased professional competence in the several specialized areas of forest resource management and forest products. It should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Science with a major in forest resources.

A minimum of 30 graduate credits is required, of which at least 20 must be earned at an established graduate campus of the University. At least 12 credits must be in courses at the 500 level, excluding F.P. 596, For. 596, and Wildl. 596.

A candidate for the degree of Master of Forest Resources may elect a minor with the permission of the committee. A minor consists of no fewer than 6 credits of integrated work in one field related to, but different from, that of the major. A minor program must meet the approval of the department or committee responsible for the minor field.

Each candidate is required to submit an acceptable paper which demonstrates an ability to apply to the professional field the knowledge gained during his or her program. Six to 9 graduate credits will be given for this paper, which will be evaluated by the student's committee, defended in an oral exam, and reviewed by a member of the Graduate Faculty not on the student's committee.

## **M.Mus. — ADDITIONAL SPECIFIC REQUIREMENTS**

The program leading to the degree of Master of Music provides training for increased professional competence in music. It should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Arts with a major in music history.

A minimum of 36 credits is required, of which at least 30 must be earned at the University Park Campus. The larger part of these credits should be above the 400 level, but the needs of the student shall be considered in arranging the best combination of courses and research for the preparation of the candidate.

A professional project, either creative or interpretative, is required. This project shall include a monograph in support of the creative or interpretative aspect of the program.

## **M.P.A. — ADDITIONAL SPECIFIC REQUIREMENTS**

The Master of Public Administration is a professional degree for students who are planning careers in public administration in local, state, and national governmental jurisdictions or in international, private, or voluntary agencies. The M.P.A. degree is offered at the University Park Campus, the Capitol Campus, and the Radnor Center for Graduate Studies.

The M.P.A. degree offered at University Park and Radnor requires a minimum of 30 graduate credits, of which 20 must be earned at the University Park or Radnor Campus. The greater portion of the courses must be at the 500 level. An M.P.A. essay or paper will also be required but will carry no graduate credit. A comprehensive final examination will be given to all candidates.

The M.P.A. degree offered at the Capitol Campus at Middletown requires a minimum of 45 graduate credits including a 9-credit field study (internship) experience and a professional master's project. The 9-credit field study requirement may be waived for students who have at least three years of full-time professional experience in relevant administrative or staff work. There is no comprehensive final examination, but an oral defense of the master's project report is required.

The program leading to the Master of Public Administration degree should be distinguished from the research-oriented program which leads to the academic degree of Master of Arts with a major in political science, in which the candidate may specialize in public administration.

## **M.Ps.Sc. — ADDITIONAL SPECIFIC REQUIREMENTS**

The Master of Psychosocial Science degree, community psychology option, is a nontraditional program designed to train students to increase the social effectiveness of community institutions. The skills emphasized are the ability to recognize community problems, to outline and implement solutions to them, and to evaluate the efficacy of the solutions. Part of the curriculum is a field-based experience that includes employing one or several of these skills.

Forty-five credits are required, 24 at the 500 level. A faculty-supervised project will focus on the applied use of community psychology. The paper produced in this effort will be orally defended.

## **M.R.P. — ADDITIONAL SPECIFIC REQUIREMENTS**

The Master of Regional Planning is a professional degree for students interested in a multidisciplinary approach to the problems of regional and community development and resource management. The program provides the student with a solid background in planning theory and techniques, emphasizing planning within a multijurisdictional context in both urban and rural areas. The program provides flexibility for students to develop an area of specialization or to pursue a concurrent degree in a discipline related to planning.

For the M.R.P. degree at the University Park Campus, a minimum of 38 approved graduate credits is required, of which 28 must be earned at University Park or at a graduate center of the University. Six graduate credits will be earned in preparing (1) a thesis or (2) a professional paper comparable in quality and scope to a graduate thesis. In addition, the student must have (1) documented evidence of a planning related work experience or 3 graduate credits in a planning practicum; and (2) approval of prior course work in the areas of economics, geography, public administration, and statistics, or 3 graduate credits must be earned in approved courses in each of these areas.

The M.R.P. degree at the Capitol Campus at Middletown requires a minimum of 45 graduate credits, 35 of which are required in planning courses, at least 6 of which will be earned in preparing (1) a problem-oriented thesis, or (2) an individual project report comparable in quality and scope to a graduate thesis, or (3) a project written in a terminal integrative course in regional planning.



# GRADUATE MAJOR PROGRAMS OF STUDY

The following degrees are the ones normally conferred in each of the designated major programs. Additional professional degrees, including the M.Agr., M.Ed., and M.Eng., have been authorized in many cases and may be offered at the discretion of the department head or program chairman and the dean of the Graduate School. For example, the M.Ed. has been authorized for all of the programs below in which a master's degree is conferred provided the program is appropriate to the preparation of teachers.

Acoustics — Ph.D., M.S., M.Eng.  
 Administration (Capitol) — M.Adm.  
 Aerospace Engineering — Ph.D., M.S.  
 Agricultural Economics — Ph.D., M.S.,  
 M.Agr.  
 Agricultural Education — Ph.D., D.Ed.,  
 M.S., M.Ed.  
 Agricultural Engineering — Ph.D., M.S.  
 Agronomy — Ph.D., M.S., M.Agr.  
 American Studies (Capitol) — M.A.  
 Anatomy (Hershey) — Ph.D., M.S.  
 Animal Industry — Ph.D., M.S., M.Agr.  
 Animal Nutrition — Ph.D., M.S.  
 Anthropology — Ph.D., M.A.  
 Architectural Engineering — M.S.  
 Architecture — M.S., M.Arch.  
 Art — M.A., M.F.A.  
 Art Education — Ph.D., D.Ed., M.S.,  
 M.Ed.  
 Art History — Ph.D., M.A.  
 Astronomy — Ph.D., M.S.  
 Biochemistry — Ph.D., M.S.  
 \*Bioengineering — Ph.D., M.S.  
 Biological Chemistry (Hershey) —  
 Ph.D., M.S.  
 Biology — Ph.D., M.S.  
 Botany — Ph.D., M.S.  
 Business Administration — Ph.D., M.S.,  
 M.B.A.  
 Business Administration/French Studies —  
 M.S./M.A., M.B.A./M.A.  
 Ceramic Science — Ph.D., M.S.  
 Chemical Engineering — Ph.D., M.S.  
 Chemistry — Ph.D., M.S.  
 Civil Engineering — Ph.D., M.S.,  
 M.Eng.  
 Classics — M.A.  
 Communication Disorders — Ph.D., M.S.,  
 M.Ed.  
 Community Systems Planning and  
 Development — Ph.D., M.S.

Comparative Literature — Ph.D., M.A.  
 Computer Science — Ph.D., M.S.  
 Counselor Education — Ph.D., D.Ed.,  
 M.S., M.Ed.  
 Curriculum and Instruction — Ph.D.,  
 D.Ed., M.S., M.Ed.  
 Dairy Science — Ph.D., M.S.  
 Developmental and Remedial Reading —  
 M.Ed.  
 Earth Sciences — D.Ed., M.Ed.  
 \*Ecology — Ph.D., M.S.  
 Economics — Ph.D., M.A.  
 Educational Administration — Ph.D.,  
 D.Ed., M.S., M.Ed.  
 Educational Psychology — Ph.D., M.S.  
 Educational Theory and Policy — Ph.D.,  
 M.A.  
 Electrical Engineering — Ph.D., M.S.  
 Engineering Mechanics — Ph.D., M.S.,  
 M.Eng.  
 Engineering Science — M.S.  
 Engineering Science (Behrend, Radnor,  
 Capitol) — M.Eng.  
 English — Ph.D., M.A., M.Ed.  
 Entomology — Ph.D., M.S., M.Agr.  
 Environmental Engineering — M.S.,  
 M.Eng., Ph.D.  
 \*Environmental Pollution Control — M.S.,  
 M.Eng., M.E.P.C.  
 Extension Education — M.Agr., M.Ed.  
 Food Science — Ph.D., M.S.  
 Forest Resources — Ph.D., M.S.,  
 M.Agr., M.F.R.  
 French — Ph.D., D.Ed., M.A. (*see also*  
 Business Administration/French Studies)  
 Fuel Science — Ph.D., M.S.  
 \*Genetics (U.P., Hershey) — Ph.D., M.S.  
 \*\*Geochemistry and Mineralogy —  
 Ph.D., M.S.

\*Intercollege Graduate Program

\*\*See Geosciences

Geography — Ph.D., M.S.  
 \*\*Geology — Ph.D., M.S.  
 \*\*Geophysics — Ph.D., M.S.  
 German — Ph.D., M.A., M.Ed.  
 Health Education — Ph.D., D.Ed., M.S.,  
 M.Ed.  
 Higher Education — D.Ed., M.Ed.  
 History — Ph.D., D.Ed., M.A., M.Ed.  
 Home Economics Education — Ph.D.,  
 D.Ed., M.S., M.Ed.  
 Horticulture — Ph.D., M.S., M.Agr.  
 Human Development and Family Studies  
 — Ph.D., M.S., M.Ed.  
 Humanities (Capitol) — M.A.  
 Industrial Engineering — Ph.D., M.S.,  
 M.Eng. (Radnor, M.Eng.)  
 Journalism — M.A.  
 Laboratory Animal Medicine (Hershey) —  
 M.S.  
 Linguistics — Ph.D., M.A.  
 Man-Environment Relations — Ph.D.,  
 D.Ed., M.S., M.Ed.  
 Mathematics — Ph.D., M.A., M.Ed.  
 Mathematics (Radnor) — M.Ed.  
 Mechanical Engineering — Ph.D., M.S.,  
 M.Eng.  
 Metallurgy — Ph.D., M.S.  
 Meteorology — Ph.D., M.S.  
 Microbiology — Ph.D., M.S.  
 Microbiology (Hershey) — Ph.D., M.S.  
 Mineral Economics — Ph.D., M.S.  
 Mineral Engineering Management —  
 M.Eng.  
 Mineral Processing — Ph.D., M.S.  
 Mining Engineering — Ph.D., M.S.,  
 M.Eng.  
 Molecular and Cell Biology — Ph.D.,  
 M.S.  
 Music — M.A., M.Mus.  
 Music Education — D.Ed., M.Ed.  
 Nuclear Engineering — Ph.D., M.S.,  
 M.Eng.  
 Nursing — M.S.  
 Nutrition — Ph.D., M.S., M.Ed.  
 Nutrition in Public Health — M.S.  
 †Operations Research — Ph.D., M.S.  
 Petroleum and Natural Gas Engineering —  
 Ph.D., M.S.  
 Pharmacology (Hershey) — Ph.D., M.S.  
 Philosophy — Ph.D., M.A.  
 Physical Education — Ph.D., D.Ed.,  
 M.S., M.Ed.

Physics — Ph.D., D.Ed., M.S., M.Ed.  
 \*Physiology (U.P., Hershey) — Ph.D.,  
 M.S.  
 Plant Pathology — Ph.D., M.S., M.Agr.  
 Political Science — Ph.D., M.A.  
 Polymer Science — Ph.D., M.S.  
 Poultry Science — M.S.  
 Psychology — Ph.D., M.S.  
 Psychosocial Science (Capitol) —  
 M.Ps.Sc.  
 Public Administration — M.P.A.  
 Public Administration (Capitol) —  
 M.P.A.  
 Recreation and Parks — Ph.D., M.S.,  
 M.Ed.  
 \*Regional Planning — M.R.P.  
 Religious Studies — Ph.D., M.A.  
 Rural Sociology — Ph.D., M.S., M.Agr.  
 School Psychology — D.Ed., M.S.,  
 M.Ed.  
 Slavic Languages and Literatures — M.A.  
 Sociology — Ph.D., M.A.  
 \*Solid State Science — Ph.D., M.S.  
 Spanish — Ph.D., M.A., M.Ed.  
 Speech Communication — Ph.D., M.A.  
 Special Education — Ph.D., M.S., M.Ed.  
 Statistics — Ph.D., M.S., M.A.  
 Teaching and Curriculum (Capitol) —  
 M.Ed.  
 Theatre Arts — M.A., M.F.A.  
 Urban and Regional Planning (Capitol) —  
 M.R.P.  
 Veterinary Science — Ph.D., M.S.  
 \*Vocational Education — Ph.D., D.Ed.  
 Vocational Industrial Education —  
 Ph.D., D.Ed., M.S., M.Ed.  
 Wildlife Management — M.S.  
 Zoology — Ph.D., M.S.

\*\*See Geosciences

\*Intercollege Graduate Program

†Dual-title Program Option



# GRADUATE MAJOR PROGRAMS AND COURSES\*

## ACOUSTICS (ACS)

JIRI TICHY, *Chairman of the Committee on Acoustics*  
Applied Research Laboratory, Applied Science Building  
814-865-6364

Degrees Conferred: Ph.D., M.S., M.Eng.

*Graduate Faculty:* Senior Members Ackerman, Baker, Brown, Brubaker, Fenlon, Hayek, Johnson, Lauchle, Martin, Michael, Neubert, Pigott, Reethof, Rowlands, Sibul, Skudrzyk, Thompson, Tichy, and Wilson.

*Graduate Faculty:* Associate Members Bienvenue, Farwell, Frost, Lawther, Macaluso, Maynard, O. H. McDaniel, S. T. McDaniel, Miller, Prout, Ricker, and Stuart.

The aim of this intercollege program is to enable the student interested in acoustics to obtain an integrated program of courses covering the fundamentals of acoustical science and the biological, communications, and engineering applications of acoustics.

Programs are arranged through a selection of appropriate courses offered by several departments in the Colleges of Science, Engineering, Education, and Arts and Architecture, as well as those specifically in the area of acoustics.

Areas of concentration include acoustic signal processing, architectural and building acoustics, noise and vibration, physical acoustics, speech and hearing, and underwater acoustics. Thesis research in the various areas may be conducted in relevant departments and in the Applied Research Laboratory.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by competence in the use of computer language, as well as a reading knowledge of a foreign language.

Entering students should hold a bachelor's degree in physics, biology, engineering, architecture, mathematics, psychology, speech and hearing, or in a closely related field; and they should have had at least one year of physics and mathematics including integral calculus. Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

In addition to the acoustics courses listed below, the following courses on acoustics and closely related areas are available: Aersp. 412, 444, 506, 511, 515, 516, 517; A.E. 458, 542; E.E. 459, 560, 561, 562; E.Mch. 401, 412, 516, 521, 522, 524A,B, 525, 527, 528, 570; M.E. 458, 522; Phys. 443, 533; Sp.Com. 413, 431; Cm.Dis. 430, 522, 531, 532, 534.

## ACOUSTICS (ACS)\*

- 401. GENERAL ACOUSTICS (3)
- 402. FUNDAMENTALS OF ACOUSTICS (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

\*A course abbreviation, a number, and a title designate each course. Course designations and official abbreviations are listed above the first course in each group. The figures in parentheses following the course title show the number of credits which may be granted for that course. In the case of courses with variable credits, the number of credits which may be earned in a single term is determined by the department or program offering the course.

A department or major program may schedule an entire section of a course below the 400 level for fewer credits than the maximum authorized. In 400- and 500-series courses an individual student may schedule fewer credits than the maximum number but in no case more than the maximum number authorized.

All courses listed under graduate major programs may not be required in the particular major.

511. UNDERWATER SOUND PROPAGATION (3) Theoretical and empirical treatment of sound propagation in the ocean, including effects of the environment, characteristics of targets, and transducers.
512. SONAR ENGINEERING (3) Theoretical and empirical treatment of problems related to the use of underwater sound in target detection and ranging.
513. MODERN ACOUSTIC SIGNAL PROCESSING (3) Probability review, representation of signals, noise processes, optimum filtering, ambiguity functions, linear and nonlinear signal processing, application to sonar systems.
514. ELECTROACOUSTIC TRANSDUCERS (3) The theory, design, and calibration of passive, linear, reciprocal electroacoustic transducers for use in both air and water media. Prerequisite: Phys. 443.
515. ACOUSTICS IN FLUID MEDIA (3) Wave propagation in stationary and moving fluids; acoustic radiation and scattering; standing waves in ducts and cavities. Prerequisites: E.Mch. 524A, Phys. 443.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-6)
597. SPECIAL TOPICS (1-6)

## ADMINISTRATION (ADMIN)

DR. HAROLD L. GILMORE, *Head, Division of Business Administration*

DR. BARBARA LEE BLEAU, *Coordinator*

The Capitol Campus

Middletown, PA 17057

717-948-6139

*Degree Conferred:* M.Adm.

*Graduate Faculty:* Senior Members Dexter, Gilmore, Murty, and Saylor.

*Graduate Faculty:* Associate Members R. Brown, T. Brown, Chisholm, G. Cole, DeRooy, Hartzler, McKenna, Murti, Posatko, and Redington.

This program is intended to meet the professional needs of practicing and potential administrators. Options are available in business administration and engineering administration. The business administration option is intended for those students who desire to pursue an administrative career in commerce, business, or industry. The engineering administration option is intended for students who wish to include courses in engineering and operations research as part of their program.

To obtain the degree three foundation courses must be satisfied, and a program of 33-47 credits must be completed. Research competence will be demonstrated by completion of the master's project. Students must register for Bus. 554 (Master's Project) for a total of 3 credits before, or at the same time as, they register for the last 6 credits of other course work.

For admission to the Master of Administration program, the student must have a baccalaureate degree from an accredited institution. Students with a 2.75 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.75 grade-point average may be made for students with special backgrounds, abilities, and interests.

Applicants are required to take the Graduate Management Admissions Test.

The program is offered only at the Capitol Campus.

## COURSES\*

ADMIN. 486. APPLICATIONS OF STATISTICAL COMPUTER PACKAGES (1) Selection and application of computer packages for statistical analysis; construction and modification of files; design of program statements. Prerequisite: 3 credits in basic statistics.

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\*Course descriptions not given below can be found under the designated field of study.



ADMIN. 500. ADMINISTRATIVE THEORY (3) History, significance, and functions of administration, theories of leadership, authority, decision making, rationality, and efficiency.

ADMIN. 505. PERSONNEL MANAGEMENT (3) Problems in effectively selecting, utilizing, and developing human resources from the viewpoint of the total organization — both private and public.

ADMIN. 510. ORGANIZATION BEHAVIOR (3) Examination of concepts of human behavior in formal organizations, systems analysis, conceptual models, and decision processes.

ADMIN. 511. ORGANIZATIONAL CHANGE AND DEVELOPMENT (3) Theory of organizational change and development; case analysis of applications in actual situations. Prerequisites: Admin. 510 and either Admin. 500 or P.Admin. 500.

ADMIN. 515. LABOR MANAGEMENT RELATIONS (3) Labor relations issues; collective bargaining agreement, negotiations, and administration; legal framework of collective bargaining; labor relations in larger social context.

ADMIN. 520. ADMINISTRATIVE MODELS (3) Formulation and solution of decision models for administrative problems. Analysis of decision making under certainty, risk, and uncertainty. Prerequisite: 3 credits in statistics.

ADMIN. 552. MULTIVARIATE STATISTICAL ANALYSIS (3) Application of statistical methods for analyzing the relationships between two or more variables, such as multiple regression. Prerequisite: 3 credits in statistics and Admin. 486.

ADMIN. 556. ECONOMIC AND BUSINESS FORECASTING (3) Application and evaluation of methods for forecasting regional economic change and business activity. Prerequisites: Bus. 380, Econ. 310.

ADMIN. 560. SAMPLING THEORY AND PRACTICE (3) Study of scientific method of obtaining representative samples, collection of information, techniques of estimation. Prerequisite: Bus. 493.

ADMIN. 561. MANAGEMENT INFORMATION SYSTEMS (3) Design and implementation of information systems directed at aiding decision making in organizations. Prerequisites: Introductory courses in accounting, management, and computer programming.

ADMIN. 589. SMALL BUSINESS MANAGEMENT PRACTICUM (1-3) Advanced study and practice in small business management through field assignments with cooperating firms to analyze and solve managerial problems.

ADMIN. 590. COLLOQUIUM (1-3)

ADMIN. 596. INDIVIDUAL STUDIES (1-6)

ADMIN. 597. SPECIAL TOPICS (1-6)

BUS. 522. OPERATIONS MANAGEMENT (3) Integration and application of decision making to operational and policy problems within the business firm. Prerequisite: Admin. 520.

BUS. 530. FINANCIAL MANAGEMENT (3) The financial aspects of management, including subjects of general interest to managers. Prerequisites: Bus. 494, Econ. 410.

BUS. 531. MANAGING FINANCIAL OPERATIONS (3) A course for financial managers: working capital management, financial planning, financial controls, reporting, financial strategies; theory and practice. Prerequisites: Admin. 520, Bus. 494.

BUS. 540. FINANCIAL AND MANAGERIAL ACCOUNTING (3) Fundamental financial and managerial accounting concepts and issues from the viewpoint of the report user. Prerequisite: 6 credits of introductory accounting.

BUS. 554. MASTER'S PROJECT (1-3) Development of an original master's project in the student's area of professional interest.

BUS. 570. MARKETING MANAGEMENT (3) Analysis of management's marketing problems, including marketing analyses, pricing, channels of distribution, promotion, competition, product strategies, and marketing research.

BUS. 571. CONSUMER BEHAVIOR (3) Factors influencing buyer behavior; contributions of the behavioral sciences to the study of selected phenomena. Prerequisite: Econ. 410.

BUS. 572. RESEARCH AND MARKETING MANAGEMENT (3) Management information needs, evaluation of research proposals and findings, methods of data collection and analysis, integration of research and decisions. Prerequisite: Bus. 570.

BUS. 584. GOVERNMENT AND BUSINESS (3) Theory, practice, and impact of government regulation of business. Prerequisite: Econ. 410 or 417.

\*BUS. 588. BUSINESS POLICY FORMULATION (3) Analysis of administrative problems from a total organization viewpoint. Case studies of actual organizations are used for analysis. Prerequisites: all core and tool courses.

BUS. 597. SPECIAL TOPICS (1-6)

B.LOG. 538. LOGISTICS SYSTEMS MANAGEMENT (3)

B.LOG. 541. SOCIOECONOMIC ANALYSIS IN TRANSPORTATION (3)

I.B. 501. THE INTERNATIONAL ENVIRONMENT (3)

I.E. 508. OPERATIONS RESEARCH: INVENTORY MODELS (3)

I.E. 509. OPERATIONS RESEARCH: WAITING LINE MODELS (3)

I.E. 510. MATHEMATICAL PROGRAMMING (3)

## AEROSPACE ENGINEERING (AERSP)

BARNES W. McCORMICK, *Head of the Department*  
233 Hammond Building  
814-865-2569

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Eisenhuth, Holl, Kaplan, Lakshminarayana, McCormick, Parkin, and York.

*Graduate Faculty:* Associate Members Morris, Smith, and Thompson.

Opportunities are available for graduate study in the following areas: low-speed aerodynamics, V/STOL aircraft, turbulence, astrodynamics, turbomachinery, aeroacoustics, plasma dynamics, rarefied gas dynamics, hydrodynamics, stability and control of aerospace vehicles, aeroelasticity, and aerospace structures.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by an intermediate knowledge of two foreign languages, by providing proof of mature and meaningful knowledge in a cultural subject of broad significance as a substitute for one of these languages, or by a comprehensive knowledge of one foreign language.

The entering student must hold a bachelor's degree in physical science, mathematics, or engineering and may be required to complete (without degree credit) undergraduate course work in fluid and solid mechanics and intermediate mathematical analysis, if not already completed. Students with a 2.70 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.70 grade-point average may be made for students with special backgrounds, abilities, and interests.

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\*Course to be taken during student's last term — recommend tool courses be completed.



**AEROSPACE ENGINEERING (AERSP)**

402. AEROSPACE DESIGN (1-3)  
*Unit A. CONCEPTUAL DESIGN (1)*  
*Unit B. PRELIMINARY DESIGN (1)*  
*Unit C. DETAILED DESIGN (1)*
403. DESIGN OF AIR TRANSPORT SYSTEMS (3)
407. AERODYNAMICS OF V/STOL AIRCRAFT (3)
410. AEROSPACE PROPULSION (3)
411. AEROELASTICITY (3)
412. TURBULENT FLOW (3)
413. STABILITY AND CONTROL OF AIRCRAFT AND MISSILES (3)
415. PHYSICAL GAS DYNAMICS (3-6)
416. INTRODUCTION TO RESEARCH AND DESIGN (1)
417. AEROSPACE THESIS (2)
420. PRINCIPLES OF FLIGHT TESTING (3)
421. (M.E. 421) INTERMEDIATE VISCOUS FLOW (3)
425. THEORY OF FLIGHT (3)
430. SPACE PROPULSION AND POWER SYSTEMS (3)
444. NOISE POLLUTION OF FLUID DYNAMIC ORIGIN (3)
450. ORBIT AND ATTITUDE CONTROL OF SPACECRAFT (3)
496. INDEPENDENT STUDIES (1-12)
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504. AERODYNAMICS OF V/STOL AIRCRAFT (3) Jet wings, high lift devices, propellers and ducted propellers, circulation and boundary layer control, unsteady airfoil theory. Prerequisite: Aersp. 407.
505. AERO- AND HYDROELASTICITY (3) Interaction of elastic systems having several degrees of freedom with fluid flows in various configurations.
506. CAVITATION (3) Flow regimes, dynamics of cavitation, prediction of the minimum pressure in the fluid, scale effects, effect of surface irregularities.
507. THEORY AND DESIGN OF TURBOMACHINERY (3) Theory and principles of machinery design: compressors, turbines, pumps, and rotating propulsors; opportunity to work out design examples.
508. FOUNDATIONS OF FLUID MECHANICS (3) Mathematical review, fluid properties, kinematics, conservation laws, constitutive relations, similarity principles, the boundary layer, inviscid flow, vorticity dynamics, wave motion.
509. DYNAMIC OF IDEAL FLUIDS (3) Irrotational flow theory, two-dimensional and axisymmetric flows, airfoil theory, complex variables, unsteady phenomena; flow with vorticity, finite wing theory. Prerequisite: Aersp. 508.
510. COMPRESSIBLE FLOW (3) Classification and solution of compressible flow problems, high-speed gasdynamics, unsteady motion, transonic and hypersonic flows, atmospheric reentry.
511. AERODYNAMICALLY INDUCED NOISE (3) Review of fluid mechanics. General theory of aerodynamic sound. Noise radiation from jets, boundary layers, rotors, and fans. Structural response.
512. VISCOUS FLOW (3) Stress-deformation relations; Newtonian fluids, Navier-Stokes equations; exact, asymptotic laminar solutions; instability, transition; similitude and turbulent boundary layer.
514. STABILITY OF LAMINAR FLOWS (3) The stability of laminar motions in various geometries as influenced by boundary conditions and body forces of various kinds.
515. FOUNDATIONS OF TURBULENCE (3) The mathematics underlying turbulence theory: descriptions, kinematics of stochastic fields; techniques of solution of linear and some nonlinear problems.
516. HOMOGENEOUS TURBULENCE (3) Dynamics: production, spectral transfer, dissipation, decay of energy; similarity theories.
517. INHOMOGENEOUS TURBULENCE (3) Dynamics: similarity, structural hypotheses; spatial, spectral budget of energy in a number of classical flows.

518. DYNAMICS AND CONTROL OF AEROSPACE VEHICLES (3) Dynamical problems of aircraft and missiles including launch, trajectory, optimization, orbiting, reentry, stability and control, and automatic control. Prerequisite: Aersp. 413 or 450.
550. ASTRODYNAMICS (3) Applications of classical celestial mechanics to space flight planning. Determination and construction of orbital parameters by approximation methods. Perturbation techniques. Prerequisite: Aersp. 450 or Astro. 460 or E.Mch. 410 or Phys. 419.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-6)
597. SPECIAL TOPICS (1-6)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## AGRICULTURAL ECONOMICS (AG EC)

JOHN W. MALONE, JR., *Head of the Department of Agricultural Economics and Rural Sociology*  
6 Weaver Building  
814-865-5461

*Degrees Conferred:* Ph.D., M.S., M.Agr.

*Graduate Faculty:* Senior Members Epp, Frey, Gamble, Hallberg, Herrmann, Hutton, Jansma, Madden, Malone, McAlexander, Partenheimer, Schutjer, and Stemberger.

*Graduate Faculty:* Associate Members Alter, Beierlein, Cordes, Crowley, Daugherty, Dum, Dunn, Fuller, Goode, Heien, Henson, Smith, Weaver, and Young.

The graduate program emphasizes economic theory and analytical techniques in the fields of farm management, production economics, agricultural marketing, resource economics, rural development, agricultural policy and prices, and in international agricultural trade and development.

There is no foreign language requirement for the Ph.D. degree; rather, the student must satisfactorily complete courses in economic theory and quantitative methods.

Students entering the master's program should have 3 credits in agricultural economics, 3 credits in economics, and 3 additional credits in either field. Students entering the doctoral program should have successfully completed courses in intermediate micro- and macroeconomic theory, in differential and integral calculus and linear algebra, and in introductory statistics. Students are permitted to enter the master's and doctoral programs with deficiencies but must pass courses to eliminate deficiencies as soon as possible.

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests. TOEFL scores are required, and Graduate Record Examination scores are optional, for applicants whose first language is not English. All other applicants are required to submit Graduate Record Examination scores.

Students in this program may elect the dual-title degree program option in operations research for the Ph.D. and M.S. degrees (see p. 249).

Students may qualify for admission to the program in population issues consisting of interdisciplinary course work with special emphasis on the economic, social, and geographic issues arising from the dynamics of population change.

## AGRICULTURAL ECONOMICS (AG EC)

401. LAND AND WATER RESOURCE POLICY (3) *Alter*
402. LAND WATER RESOURCE ECONOMICS (3) *Epp*
403. RURAL COMMUNITY DEVELOPMENT (3) *Cordes*
407. FARM PLANNING AND FINANCIAL MANAGEMENT (3) *Grisley*



410. AGRICULTURAL REAL ESTATE APPRAISAL (3) *Gingrich*
  420. AGRICULTURAL PRICES (3) *Stemberger*
  450. INTERNATIONAL AGRICULTURAL TRADE AND DEVELOPMENT (3) *Schutjer*
  460. INDUSTRIAL ORGANIZATION IN FOOD PROCESSING AND DISTRIBUTION (3) *Dunn*
  461. DECISION MAKING IN AGRICULTURAL MARKETING FIRMS (3) *Beierlein*
  495. INTERNSHIP IN AGRIBUSINESS AND RURAL DEVELOPMENT (10)
  496. INDEPENDENT STUDIES (1-12)
  497. SPECIAL TOPICS (1-6)
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501. MICROECONOMIC DECISION MAKING IN AGRICULTURE (3) Application of microeconomic theory to problems and decisions of farm households and agricultural firms. Prerequisite: Econ. 490 or 502 or Stat. 462. *Madden*
  502. ECONOMICS OF NATURAL RESOURCES AND RURAL DEVELOPMENT (3) Emphasis will be placed on the application of economic concepts to problems and policies in rural areas. Prerequisites: Econ. 502, 503. *Goode*
  503. ECONOMIC PERFORMANCE OF FOOD AND AGRICULTURAL MARKETING (3) Economic analysis of food marketing firms and institutions; identification and measurement of dimensions of market performance; public policy. Prerequisite: Econ. 502. *Dunn*
  510. ECONOMETRICS I (Econ. 510) (3) General linear model, multicollinearity, specification error, autocorrelation, heteroskedasticity, restricted least squares, functional form, dummy variables, limited dependent variables. Prerequisite: Econ. 490 or Stat. 462 or 501. *Heien*
  511. ECONOMETRICS II (Econ. 511) (3) Stochastic regressors, distributed lag models, pooling cross-section and time-series data, simultaneous equation models. Prerequisite: Ag.Ec. 510. *Weaver*
  517. RESOURCE ECONOMICS AND RURAL DEVELOPMENT (3) Present, apply, and empirically implement the concepts used for analyzing resource and rural development problems. Prerequisites: Econ. 502, 503. *Goode*
  519. ECONOMIC ANALYSIS OF LAND AND WATER RESOURCE POLICY (3) History and analysis of natural resource policies, including U.S. public land disposal, conservation, and environmental protection policies. Selected current topics. Prerequisites: Econ. 502, Ag.Ec. 517, 518.
  525. RESEARCH METHODS IN RURAL SOCIAL SCIENCES (3) Scientific method in planning and conducting research. Prerequisite: 9 credits in social sciences.
  527. QUANTITATIVE METHODS I (3) Quantitative techniques applied to agricultural economic issues. Prerequisite: Econ. 502. *Partenheimer*
  528. QUANTITATIVE METHODS II (3) Advanced topics in quantitative techniques applied to agricultural economic issues. Prerequisite: Ag.Ec. 527.
  534. DECISION MAKING IN THE FARM AND AGRIBUSINESS FIRM (2) Analysis of firm-level production problems, static and dynamic; single- and multiple-period decision models under certainty and uncertainty. Prerequisites: Econ. 521, Ag.Ec. 527, 511. *Grisley*
  536. AGRICULTURAL COMMODITY MARKETS (3) Specification, identification, and estimation of models for use in the evaluation and control of agricultural market behavior. Prerequisite: Econ. 510 or 521 or Ag.Ec. 511.
  538. POLICY FOR THE FOOD AND AGRICULTURE SECTOR (3) Policy formation; policies for food and agriculture, consequences for farmers, consumers, resources; farm program benefits and costs; current issues. Prerequisites: Ag.Ec. 511, Econ. 521, 522. *Hallberg*
  595. (Econ. 595) SEMINAR IN ECONOMETRIC THEORY (3) Theories and methods relevant to the application of statistical methods to economics. Prerequisite: Econ. 510.
  596. INDIVIDUAL STUDIES (1-6)
  602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## AGRICULTURAL EDUCATION (AG ED)

SAMUEL M. CURTIS, *Interim Head of the Department*  
102 Armsby Building  
814-865-1688

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Senior Members Curtis, Howell, Love, and Stinson.

*Graduate Faculty:* Associate Members Evans, Heinsohn, Lindley, Mortensen, Morton, and Yoder.

Graduate programs emphasize the professional improvement of teachers and of agricultural extension personnel with education responsibilities. They provide advanced preparation for employment in administration, supervision, teaching including teacher education, and research in agricultural education and related fields. A minor may be taken in an area of agricultural science, technology, or in general studies. Programs may include courses needed for certification in other fields of education. Successful completion of one year of teaching or equivalent professional experience is required prior to completion of the M.S. or M.Ed. degree.

There are no foreign language requirements for the Ph.D. in agricultural education; however, Engl. 418 and Sp.Com. 212 or equivalent communication courses are required.

Admission to a doctoral program requires (1) a 3.00 grade-point average for graduate work, (2) a minimum of two years of successful public, private, or extension teaching experience before the degree is completed, (3) evidence of ability to write a scholarly paper or thesis, and (4) a teaching-level competence in English.

Prerequisite for admission to a master's program is a minimum of 18 credits in professional education courses — including educational psychology and student teaching — or certification as a teacher of agriculture or equivalent professional experience. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission to the M.S. or M.Ed. program. The best-qualified applicants for all degrees will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum grade-point averages may be made for students with special backgrounds, abilities, and interests.

## AGRICULTURAL EDUCATION (AG ED)

- 400v. EDUCATIONAL PROGRAMS IN AGRICULTURE FOR DEVELOPING COUNTRIES (3)
- 418v. SURVEY OF VOCATIONAL EDUCATION IN AGRICULTURE (1-4)
- 420v. INSTRUCTIONAL MEDIA IN AGRICULTURE (1-6)
- 422v. SUPERVISION OF VOCATIONAL EDUCATION IN AGRICULTURE (1-4)
- 424v. OCCUPATIONAL GUIDANCE IN AGRICULTURAL INDUSTRY (1-4)
- 426v. ADULT EDUCATION IN AGRICULTURE (1-4)
- 434v. AGRICULTURAL DEVELOPMENTS (1-6)
- 440. COMMUNICATION METHODS AND MEDIA IN AGRICULTURE (3)
- 450. METHODOLOGY OF EXTENSION EDUCATION (3)
- 490, 490v. COLLOQUIUM (1-3)
- 495v. STUDENT TEACHING IN AGRICULTURE (8)
- 496, 496v. INDEPENDENT STUDIES (1-12)
- 497, 497v. SPECIAL TOPICS (1-6)

501v. AGRICULTURAL EDUCATION IN THE UNITED STATES (1-3) Historical development, social and philosophical foundations, and current status in relation to the total vocational-technical education program.

502v. TEACHING AGRICULTURE (1-3) Vocational education objectives, learning theory, class instruction, cooperative occupational experience, and evaluation.

508v. ADMINISTRATION AND SUPERVISION OF AGRICULTURAL EDUCATION (1-3) Administration of state and district systems of vocational-technical education; supervision of teachers of agriculture.



509v. **TEACHER EDUCATION IN AGRICULTURE (1-6)** Organization and administration of university programs of teacher education in agriculture, including preservice preparation, continuing education, research, and other services.

520v. **SCIENTIFIC METHOD IN THE STUDY OF AGRICULTURAL EDUCATION (1-4)** Methods of procedure in investigation and experimentation in education, accompanied by a critical examination of studies made in agricultural education.

521v. **SCIENTIFIC METHOD IN THE STUDY OF AGRICULTURAL EDUCATION (1-4)** Continuation of Ag.Ed. 520v; emphasis upon statistical techniques for students' individual problems.

524v. **PROGRAM DEVELOPMENT IN AGRICULTURAL EDUCATION (1-3)** Analysis of occupational needs of students and employment prospects; organization of courses of study and other activities of teachers.

530. **AGRICULTURAL COLLEGE TEACHING (3)** Selection and organization of subject matter for specific courses, methods of learning, teaching devices, techniques of teaching, and measurement of results of teaching.

590, 590v. **COLLOQUIUM (1-3)**

596, 596v. **INDIVIDUAL STUDIES (1-6)**

597, 597v. **SPECIAL TOPICS (1-6)**

## AGRICULTURAL ENGINEERING (AG E)

HAROLD V. WALTON, *Head of the Department*  
250 Agricultural Engineering Building  
814-865-7792

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Manbeck, Morrow, Persson, Stephenson, and Walton.

*Graduate Faculty:* Associate Members DeTar, Hilton, Hoover, Jarrett, Keppeler, Kjelgaard, Sastry, Schroeder, and Shaw.

Graduate programs are available in the areas of the physical properties of biomaterials, protected plant and animal production, food and engineering, agricultural structures, agricultural byproduct utilization, agricultural systems engineering, biomass energy conversion, alternative energy sources, agronomic crop mechanization, forage and animal interaction, horticultural engineering, microclimate modification, soil dynamics, and infiltration, drainage, and irrigation.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by either (1) 9 credits of courses in an approved sequence or (2) a foreign language. Prior approval by the Ph.D. Advisory Committee must be obtained to study a foreign language other than French, German, Russian, or Spanish.

Excellent facilities, including equipment and instrumentation, are available for research in the designated areas. Among the special facilities are controlled environmental chambers, plant growth structures for modified atmosphere, a general-purpose analog computer, data processing systems including remote job entry for access to University computer facilities, and laboratories for research on physical properties of agricultural materials. Special equipment is available for physical properties work, including Instron and Ametek testing machines complete with environmental chambers and data acquisition systems, a polariscope for photoelastic stress analysis, triaxial testing equipment, and other unique and specially designed testing facilities. Special facilities outside the Agricultural Engineering Building include a mushroom research and demonstration facility, an anaerobic digester for methane gas generation, and the facilities of a 1,525-acre agricultural research center for cooperative work with agronomic and horticultural production systems.

Prerequisite to major work is the completion of an undergraduate major in engineering. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for ad-

mission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

## AGRICULTURAL ENGINEERING (AG E)

401. FARM MECHANICS FOR TEACHERS OF VOCATIONAL AGRICULTURE (1½-9)
412. PHYSICAL PROCESSES IN FOOD MANUFACTURING I (3)
413. PHYSICAL PROCESSES IN FOOD MANUFACTURING II (3)
414. PHYSICAL PROCESSES IN FOOD MANUFACTURING III (2)
420. SEMINAR (1)
423. PHYSICAL AND RHEOLOGICAL MEASUREMENTS ON BIOMATERIALS (3)
424. FARM MACHINERY MANAGEMENT (3)
432. PRINCIPLES OF AGRICULTURAL BUILDINGS (3)
433. MECHANICAL PROPERTIES OF AGRICULTURAL MATERIALS (3)
434. PRINCIPLES AND DESIGN OF FARM TRACTORS AND MACHINES (3)
435. PRINCIPLES OF AGRICULTURAL PROCESSING (3)
437. PRINCIPLES OF SOIL-WATER ENGINEERING (3)
438. AGRICULTURAL MEASUREMENTS AND CONTROL SYSTEMS (3)
457. LAND WASTE DISPOSAL (3)
460. POWER SOURCES FOR AGRICULTURE (2)
461. HYDRAULIC POWER IN AGRICULTURAL EQUIPMENT (2)
462. DESIGN OF AGRICULTURAL STRUCTURES (2)
463. THERMAL, OPTICAL, AND ELECTRICAL PROPERTIES OF AGRICULTURAL MATERIALS (3)
464. DESIGN OF AGRICULTURAL MACHINES (2)
467. DESIGN OF DRAINAGE AND IRRIGATION SYSTEMS (2)
469. OPTIMIZATION OF AGRICULTURAL SYSTEMS AND ENERGY UTILIZATION (3)
488. AGRICULTURAL ENGINEERING DESIGN PROBLEM (1-2 per term)
490. AGRICULTURAL MECHANIZATION SEMINAR (1)
496. INDEPENDENT STUDIES (1-12)
497. SPECIAL TOPICS (1-6)
  
500. ADVANCED ELECTRO-AGRICULTURE (1-6) Investigations in the application of electrical energy to processing, storing, and handling agricultural products. Seminar, written reports.
501. ADVANCED FARM MACHINERY (1-6) Application of agricultural engineering principles to design and operation of farm machinery.
502. FARM STRUCTURES PROBLEMS (1-6) Analysis of farm structures design problems.
503. PHYSICAL PROPERTIES OF PLANT AND ANIMAL PRODUCTS (3) Physical characteristics; mechanical, rheological, thermal, electrical, and optical properties in relation to handling, storage, processing, and quality evaluation.
505. EXPERIMENTAL AND APPLIED INSTRUMENTATION (4) The theory and application of electronics for instrumentation and experimental research.
507. PROBLEMS IN SOIL WATER ENGINEERING (1-6) Analysis of engineering problems relating to irrigation, drainage, or erosion control.
509. RESEARCH IN AGRICULTURAL ENGINEERING (1-4)
520. AGRICULTURAL ENGINEERING SEMINAR (1-3) Reports on research and special topics.
596. INDIVIDUAL STUDIES (1-6)
597. SPECIAL TOPICS (1-6)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)



## AGRONOMY (AGRO)

JAMES L. STARLING, *Head of the Department*  
117 Tyson Building  
814-865-6541

*Degrees Conferred:* Ph.D., M.S., M.Agr.

*Graduate Faculty:* Senior Members Baker, Bollag, Ciolkosz, Cleveland, Cunningham, Duich, Fox, Fritton, Hall, Harrington, Heald, Hill, L. Johnson, M. Johnson, Jung, Kendall, Marshall, McKee, Petersen, Pionke, Risius, Rogowski, Shenk, Starling, Templeton, Waddington, and Watschke.

*Graduate Faculty:* Associate Members Baylor, Berg, Cole, Fox, Gustine, Hartwig, Hatley, Knievel, Lanyon, Pennock, Shipp, and Stringer.

Students may specialize in soil science, crop science, or soil and crop management. Soil science specialties include genesis and morphology, chemistry, biochemistry, fertility, mineralogy, physics, and remote sensing. Crop science specialties include breeding and genetics, crop quality, crop and weed ecology, and physiology.

The communication and foreign language requirement for the Ph.D. degree may be met either by demonstrating a knowledge of at least one foreign language or by completing at least 6 credits of course work in an area of English communications approved by the student's advisory committee.

Prerequisites for major work in agronomy vary with the area of specialization and the degree sought, but courses in chemistry, mathematics, physics, geology, basic and applied biological sciences, and English communication skills are required. Applicants for the M.S. degree should have a baccalaureate degree including 76 credits of basic and applied natural sciences. For the M.Agr. degree program, an applicant must present a baccalaureate degree in agricultural or forest science. Admission to the Ph.D. program requires an M.S. or equivalent degree, and 100 credits (including credits of the baccalaureate degree) of basic and applied natural sciences. Students who lack some of the prerequisite courses may be admitted but are required to take these courses without degree credit.

A minimum junior-senior grade-point average of 3.00 is required for admission to the agronomy master's degree programs. In addition, a grade-point average of 3.00 is required in all courses in the biological and physical sciences regardless of when taken. Exceptions to these requirements may be made for students with special backgrounds, abilities, and interests. Applicants for the Ph.D. program will be evaluated principally on the quality of work completed in previous graduate programs. The best-qualified applicants will be accepted up to the number of spaces that are available for new students.

## AGRONOMY (AGRO)

401. SOIL COMPOSITION AND PHYSICAL PROPERTIES (3) *Fritton and Johnson*
402. CHEMISTRY OF SOILS AND FERTILIZERS (3) *Fox*
410. CROP SCIENCE (3) *Knievel*
411. BREEDING OF FIELD CROPS (3) *Cleveland*
415. SOIL MORPHOLOGY, MAPPING, AND LAND USE (3) *Petersen*
416. SOIL GENESIS AND CLASSIFICATION (3) *Ciolkosz*
417. FOREST SOILS (3) *Pennock*
419. SOIL PROPERTIES (4) *Baker*
420. AGRONOMIC CASE STUDIES IN SOIL, PLANT, AND WATER MANAGEMENT (3) *Lanyon*
422. CONSERVATION OF SOIL AND WATER RESOURCES (3) *Cunningham*
423. FORAGE CROP MANAGEMENT (3) *Stringer*
425. FIELD CROP MANAGEMENT (3) *Hatley*
438. PRINCIPLES OF WEED CONTROL (3) *Hartwig*
439. HERBICIDE PROPERTIES AND MODE OF ACTION (3)
495. INTERNSHIP (1-5)
496. INDEPENDENT STUDIES (1-12)
497. SPECIAL TOPICS (1-6)

501. SOIL FERTILITY (3) Soil-plant relations emphasizing recent concepts of ion accumulation by plants as affected by soil conditions and plant physiology. Prerequisites: Agro. 402, Biol. 441. *Hall*
506. SOIL PHYSICAL CHEMISTRY (4) Colloidal chemistry of soils emphasizing ion adsorption, double-layer theory, diffusion, and water properties. Prerequisites: Agro. 419; Bioch. 425 or Chem. 451. *Baker*
507. SOIL PHYSICS (3-4) Soil physical properties emphasizing water, heat, gas, and ion movement in unsaturated soils. Laboratory included with 4 credits. Prerequisites: 6 credits each of calculus, physics, and soils. *Fritton*
509. METHODS OF GENETIC ANALYSIS (3) Methods of qualitative genetics. Tests of hypotheses, homogeneity, linkage detection, calculations of recombination values, monosomic analysis, and tetrasomic inheritance. Prerequisite: 6 credits of genetics or plant breeding. *Cleveland*
510. CYTOGENETICS IN PLANT BREEDING (3) Chromosomal heredity of agricultural plants. Chromosome morphology; cytogenetic behavior of aneuploids, haploids, auto- and allopolyploids, and interspecific hybrids. Prerequisite: 6 credits of genetics including 3 credits of cytogenetics or cytology. *Cleveland*
511. BIOMETRICAL PLANT BREEDING (3) Quantitative genetics of plant populations; applications to breeding methodology and selection. Prerequisites: Agro. 512 and 3 credits of plant breeding. *Hill and Risius*
512. FIELD PLOT TECHNIQUE (4) Ramifications of analysis of variance techniques; combining and analyzing data from several experiments; selection of valid error terms. Prerequisite: Ag. 400 or Stat. 200. *Risius*
515. NUTRITIVE VALUE OF CROP PLANTS (3) Biochemical, physiological, genetic, and morphological nature of crop plants related to animal response. Laboratory includes nutritive evaluation procedures. Prerequisites: 3 credits of crop production and 6 credits of biochemistry and/or nutrition. *Shenk*
517. CROP ECOLOGY AND PHYSIOLOGY (3) Ecological and physiological factors affecting the productivity of crop plants. Prerequisite: Agro. 410. *McKee*
518. RESPONSES OF CROP PLANTS TO ENVIRONMENTAL STRESS (3) Physiological and ecological aspects of the response of crop plants to environmental stresses in establishment, persistence, and reproduction. Prerequisite: Agro. 410. *McKee*
519. NATURE OF SOIL MINERALS (3) Constituent minerals of soils: modern methods for identification; relations to soil formation and agricultural practices. Prerequisite: Agro. 401. *Johnson*
545. THE APPLICATION OF STATISTICS TO FIELD EXPERIMENTS (4) Use of advanced experimental designs in planning, analyzing, and interpreting experiments; includes lattice designs, factorials, confounding, simple and multiple covariance techniques. Prerequisite: Agro. 512. *Risius and Shenk*
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-6)
597. SPECIAL TOPICS (1-6)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## AMERICAN STUDIES (AM ST)

IRWIN RICHMAN, *In Charge of the Graduate Program in American Studies*  
The Capitol Campus  
Middletown, PA 17057  
717-948-6189

*Degree Conferred:* M.A.

*Graduate Faculty:* Senior Members R. Graham, Gross, Lear, Richman, Tischler, and G. Wolf.

*Graduate Faculty:* Associate Members Barton, Churchill, T. Graham, and Patterson.



This program emphasizes the study of American society as a whole, not as interpreted by a single discipline, but in the larger context of a culture. The purpose of the program is to provide the student with the opportunity to acquire knowledge and understanding within any of the following areas: ethnic composition and demographic problems of the American people; regional characteristics; the technological base of American civilization; economic, political, and social institutions; the media of communication; artistic expression, particularly in art, architecture, literature, and music; philosophy and values; and the dynamics and interrelationships of all of these.

The student is required to take a minimum of 30 credits, including at least 18 credits in the 500 series. A maximum of 24 of these 30 credits shall be taken within the program area. An original, scholarly master's paper or creative production initiated by the student, supervised by an appropriate professor, and judged by a committee is required. One to 6 credits can be accumulated during work on the master's production.

For admission to the master's program, a student must have received a baccalaureate degree from an accredited institution, earned under residence and credit conditions substantially equivalent to those required by The Pennsylvania State University. Social sciences and the humanities are not required as prerequisites, though it is anticipated that students will have had work in these areas. The application, transcripts, and a letter outlining personal goals and reasons for applying for the program should be sent directly to the Graduate Office, The Capitol Campus, Middletown, PA 17057.

## REQUIRED COURSES

AM.ST. 500. THEORY AND METHODS (3) Study of the methods and materials of American Studies scholarship, compilation of bibliographies, the writing of scholarly papers, and proper documentation.

AM.ST. 580. PROJECTS IN AMERICAN STUDIES (1-6) Independent exploration within American Studies; evidenced by major paper, film, exhibition, or specialized examination.

APPROPRIATE COURSES may be taken from the following list and from 500-level courses in other fields with the concurrence of the student's adviser.

AM.ST. 511. PIVOTAL BOOKS (3-9) Exploration of a number of books which have been particularly influential in shaping thinking about American civilization.

AM.ST. 530. TOPICS IN AMERICAN FOLKLORE (3) A detailed exploration of aspects of folklore and folklife in America.

AM.ST. 533. AMERICAN CIVILIZATION IN THE EIGHTEENTH CENTURY (3-9) Detailed investigation of specific topics in eighteenth-century American civilization.

AM.ST. 534. AMERICAN CIVILIZATION IN THE NINETEENTH CENTURY (3-9) Representative interdisciplinary investigation of social, historical, economic, and aesthetic forces predominant in nineteenth-century America.

AM.ST. 535. AMERICAN CIVILIZATION IN THE TWENTIETH CENTURY (3-9) Detailed investigation of specific periods or topics in twentieth-century American civilization.

AM.ST. 570. TOPICS IN AMERICAN ART (1-6) Various themes within the American arts will be explored under this rubric.

AM.ST. 575. MUSEUM INTERNSHIP (3) A supervised museum internship experience featuring a "hands-on" introduction into aspects of the curatorial profession. Prerequisite: permission of instructor.

AM.ST. 590. COLLOQUIUM (1-3)

AM.ST. 596. INDIVIDUAL STUDIES (1-6)

AM.ST. 597. SPECIAL TOPICS (1-6)

ADDITIONAL COURSES may be taken from the following list and from 400-level courses in other fields with the concurrence of the student's adviser.\*

\*Descriptions of these courses may be found in *The Capitol Campus Catalog*.

- AM.ST. 400. AMERICAN COLONIAL EXPERIENCE
- AM.ST. 401. AMERICAN REVOLUTION AND EARLY NATIONAL EXPERIENCE
- AM.ST. 403. INTELLECTUAL FOUNDATIONS OF AMERICAN CULTURE
- AM.ST. 431. THE AMERICAN CHARACTER
- AM.ST. 442. AMERICAN FOLKLORE
- AM.ST. 445. AMERICAN PHILOSOPHY
- AM.ST. 451. CIVIL WAR AND RECONSTRUCTION
- AM.ST. 452. THE AMERICAN RENAISSANCE
- AM.ST. 453. THE GILDED AGE AND THE PROGRESSIVE IMPULSE
- AM.ST. 454. AMERICA'S POLITICAL PARTIES
- AM.ST. 456. MASS CULTURE: THE POPULAR ARTS IN AMERICA
- AM.ST. 457. IMMIGRANTS AND AMERICANS
- AM.ST. 458. CONTEMPORARY AMERICA
- AM.ST. 459. AMERICA'S COMING OF AGE 1914-1939
- AM.ST. 460. AMERICAN ART AND ARCHITECTURE
- AM.ST. 463. AMERICAN MUSIC
- AM.ST. 469. AMERICAN INDIAN ETHNOLOGY
- AM.ST. 470. REGIONALISM IN AMERICA
- AM.ST. 474. (Econ. 474) AMERICAN ECONOMIC DEVELOPMENT
- AM.ST. 479. UNITED STATES DIPLOMATIC HISTORY
- AM.ST. 480. MUSEUMS AND CULTURE
- AM.ST. 491. SEMINAR IN AMERICAN CULTURE
- AM.ST. 496. INDEPENDENT STUDIES (1-12)
- AM.ST. 497. SPECIAL TOPICS (1-6)
- PUB.PL. 403. CONTEMPORARY U.S. FOREIGN POLICY
- PUB.PL. 470. THE PRESIDENCY AND THE EXECUTIVE PROCESS

## ANATOMY (ANAT)

BRYCE L. MUNGER, *Chairman of the Department*  
 The Milton S. Hershey Medical Center  
 Hershey, PA 17033  
 717-534-8650

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Baird, Leure-duPree, Munger, Page, Pubols, and Zagon.

*Graduate Faculty:* Associate Member Hwang.

The graduate program emphasizes the general areas of gross anatomy, histology/cytology, neuroanatomy/neurophysiology, or appropriate combinations of these areas. Approaches offered include morphological (descriptive, comparative, developmental), functional (physiological, chemical), and experimental. The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of one foreign language.

A bachelor's degree reflecting a reasonable background in zoology or biology, mathematics, and chemistry is required. Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. Applicants must provide complete transcripts and two letters of recommendation. Scores from the Graduate Record Examination and a personal interview are desirable.

This program is offered only at The Milton S. Hershey Medical Center.



**ANATOMY (ANAT)**

501. **FUNDAMENTALS OF GROSS ANATOMY I (3)** Macroscopic structure of the upper extremity, head, and neck, with emphasis on normal organization, functional correlations, and clinical significance.
502. **FUNDAMENTALS OF GROSS ANATOMY II (3)** Macroscopic structure of the thorax, abdomen, pelvis, and lower extremity, with emphasis on normal organization, functional correlations, and clinical significance. Prerequisite: Anat. 501.
505. **MICROSCOPIC ANATOMY (4)** Microscopic organization of tissues and cells; interrelationships of cells; chemical and functional specializations of cells.
510. **NEUROBIOLOGY (3)** Morphology and function of the sense organs, general organization of the brain, and physiological studies of central nervous system function.
512. **HUMAN EMBRYOLOGY (2)** A basic study of the development of the human embryo including gamete production and fusion, implantation, and organogenesis.
513. **COMPARATIVE MORPHOGENESIS (3)** A descriptive and experimental study of vertebrate and invertebrate development.
515. **DEVELOPMENTAL NEUROBIOLOGY (2)** Development of the nervous system in all aspects.
530. **DISSECTION (2-4)** Intensive laboratory study of selected regions of the human body. Coverage and credit arranged by consultation.
535. **SUBMICROSCOPIC ANATOMY (3)** Current literature on molecular and micellar organization of cells and tissues in diverse systems; application of interference and electron microscopy. Prerequisite: Anat. 505.
542. **COMPARATIVE NEUROLOGY (3)** Topics in functional anatomy and neurophysiology. The comparative approach to the organization of the mammalian nervous system will be stressed. Prerequisite: Anat. 510.
543. **SENSORY PROCESSES (3)** Morphological, physiological, and psychophysical aspects of mammalian sensory systems; emphasizing somatic, sensory, visual, and auditory systems. May be repeated. Prerequisite: Anat. 510.
545. **COMPARATIVE AUDITORY AND VISUAL ANATOMY (3-5)** An introduction to the morphology and evolution of the vertebrate eye and ear; individualized laboratory work arranged by consultation.
550. **SEMINAR IN QUANTITATIVE OPTICS (3)** Study of the various types of light microscopy instruments and application of these tools to quantitative measurements in biological systems. Prerequisite: Anat. 505.
590. **COLLOQUIUM (1-3)**
596. **INDIVIDUAL STUDIES (1-6)**
597. **SPECIAL TOPICS (1-6)**

**ANIMAL INDUSTRY (A I)**

PAUL J. WANGSNESS, *Head of the Department of Dairy and Animal Science*  
 324 Animal Industries Building  
 814-865-1362

*Degrees Conferred:* Ph.D., M.S., M.Agr.

*Graduate Faculty:* Senior Members Cowan, Hershberger, Sherritt, Wangsness, Wilson, and Ziegler.

*Graduate Faculty:* Associate Members Burdette, Cash, Etherton, Hagen, Harpster, King, and Merritt.

Opportunities are available for graduate study and research in breeding and genetics, nutrition and feed technology, physiology, animal management systems, growth and body composition, and meat science. Ruminant, nonruminant, small animal, and wildlife species are available.

The M.Agr. is a professional program designed to prepare individuals for specialist and management positions in county agricultural extension, government, or industry and does not require a thesis. The academic M.S. and Ph.D. programs require a thesis and are designed for those primarily interested in education and research. The requirements of these programs are detailed in the departmental publication, *Requirements of the Graduate Programs in Animal Industry*. The communication and foreign language requirements for the Ph.D. degree may be satisfied by competence in either one foreign language or communications skills.

For admission the student must complete an undergraduate major in animal science or a closely related field. Students who lack some of the course prerequisites may be admitted but are required to take the prerequisite courses without graduate degree credit. Applicants are required to submit Graduate Record Examination scores. Students with a 2.80 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.80 grade-point average may be made for students with special backgrounds, abilities, and interests.

### ANIMAL INDUSTRY (A I)

- 406. SWINE MANAGEMENT AND PRODUCTION (3)
- 407. ADVANCED HORSE PRODUCTION AND MANAGEMENT (2)
- 408. SHEEP PRODUCTION AND MANAGEMENT (3)
- 409. BEEF PRODUCTION AND MANAGEMENT (3)
- 423. ADVANCED LIVESTOCK SELECTION (2)
- 424. ANIMAL INDUSTRY SEMINAR (1 per term)
- 431. ADVANCED MEAT SELECTION AND GRADING (2)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

505. ADVANCED ANIMAL BREEDING (1-5) Special problems in animal genetics as applied to breeding and improvement of horses, cattle, sheep, and swine. Prerequisite: An.Sc. 322.

510. ANIMAL SCIENCE RESEARCH METHODS (3) Application of scientific method; experimental design and procedures; analyzing, interpreting, and reporting research results. Prerequisite: Ag. 400.

514. ANIMAL GROWTH AND DEVELOPMENT (3) Animal life cycles; nature of growth and development; effects of biological, environmental, social, and psychological variants; homeostasis and organismic theory. Prerequisites: 3 credits in biochemistry and 3 credits in physiology.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

NOTE: See *Animal Nutrition, Physiology, and Food Science*. Also see *Animal Science* under "Other Graduate Courses."

### ANIMAL NUTRITION (A NTR)

ROLAND M. LEACH, *Chairman of the Committee on Animal Nutrition*  
205 Animal Industries Building  
814-865-5082

Degrees Conferred: Ph.D., M.S.



*Graduate Faculty:* Senior Members Cowan, Hershberger, Kesler, Leach, McCarthy, Mendez, Muller, Scholz, and Wangness.

*Graduate Faculty:* Associate Members Etherton, Harpster, Roush, Shellenberger, and Sweeney.

This is an interdepartmental graduate program designed to enable students to obtain thorough training in animal nutrition. The program is under the direction of a committee composed of graduate faculty members of the Departments of Animal and Dairy Science, Poultry Science, and Veterinary Science, and the Human Performance Research Laboratory. Programs are offered in ruminant and nonruminant nutrition, including physiology of nutrition; nutritional requirements for productive functions; metabolism of carbohydrates, lipids, proteins, vitamins, and minerals; and regulation of food intake and other metabolic functions.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by options selected from designated areas including, but not restricted to, foreign languages.

Undergraduate preparation should include organic and analytical chemistry, physics, biology, and mathematics. Students may be admitted with limited deficiency but are required to make up undergraduate deficiencies without graduate credit.

Students should have an appropriate background and a 3.00 average in the major area and in related sciences for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum requirements may be made for students with special backgrounds, abilities, and interests.

The following nutrition courses are offered by participating departments, and their descriptions may be found under the listings of the respective departments: D.Sc. 511, Pty.Sc. 502, and V.Sc. 535. Courses related to animal nutrition can be found under the following listings in this bulletin: Animal Industry, Biochemistry, Dairy Science, Food Science, Physiology, Poultry Science, and Veterinary Science. For other graduate courses in this subject area see courses listed under Nutrition such as Nutr. 552, 556, and 557.

## **ANIMAL NUTRITION (A NTR)**

- 401. PHYSIOLOGY OF NUTRITION (3)
- 420. NUTRITION AND FEED TECHNOLOGY (2)
- 421. APPLIED FEEDING OF BEEF CATTLE AND SHEEP (1)
- 422. APPLIED FEEDING OF DAIRY CATTLE (1)
- 423. APPLIED FEEDING OF SWINE, POULTRY, AND LABORATORY ANIMALS (1)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 501. ENERGY METABOLISM (3) Integration of biochemical, nutritional, and physiological processes in energy metabolism; concepts underlying the application of bioenergetics and calorimetry to metabolism. Prerequisites: 3 credits each in nutrition and physiology; Bioch. 402.
- 503. MICRONUTRIENTS: NUTRITION, METABOLISM, AND FUNCTION (2) Functional approach to the study of vitamins and trace elements in the nutrition and metabolism of animals and man. Prerequisites: 3 credits each in biochemistry, nutrition, and physiology.
- 505. RUMINOLOGY (3) Physiological, biochemical, and microbiological activities occurring within the rumen and the relation of rumen function to animal response. Prerequisites: at least one course in each of the following areas: animal nutrition, physiology, microbiology, and biochemistry.
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)

## ANTHROPOLOGY (ANTHY)

PAUL T. BAKER, *Head of the Department*  
409 Carpenter Building  
814-865-2509

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Senior Members P. Baker, Dyke, Eckhardt, Escobar, Hunt, Michels, Morrill, Sanders, and Webster.

*Graduate Faculty:* Associate Members T. Baker, Hatch, and Kurland.

The master's program is designed to train students in general anthropology. The doctoral program is structured to train students in the following areas of specialization: ethnology (with subspecialization in social anthropology, demographic anthropology, cognitive anthropology, or cultural evolution and ecology); archaeology (with subspecialization in cultural ecology, analytical approaches, technological methods, or culture areas); biological anthropology (with subspecialization in human adaptability, genetics, biological demography, human evolution, or the behavioral biology of human and nonhuman primates).

M.A. candidates may submit either a thesis or a term paper. If the latter is chosen, 6 credits in 500-level courses in the major field must be scheduled in lieu of thesis credits. The M.A. degree may be bypassed by exceptional candidates for the Ph.D. degree.

The communication and foreign language requirement for the Ph.D. degree includes a reading knowledge of a foreign language plus an option from among additional foreign languages, field languages, linguistics, and statistics.

Undergraduate preparation must include 12 credits in anthropology and archaeology or their equivalent. A student with an excellent record but who does not meet these requirements may be admitted provided course deficiencies are made up without graduate credit. Students with a 3.00 or higher junior-senior average and with appropriate course backgrounds who have research interests directly related to the special anthropological competences within the department will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

## ANTHROPOLOGY (ANTHY)

- 400. HUMAN EVOLUTION: THEORY AND PROCESS (3)
- 401. HUMAN EVOLUTION: THE MATERIAL EVIDENCE (3)
- 402. HUMAN ECOLOGY (3)
- 405. PRIMATOLOGY (3)
- 408. DEMOGRAPHIC METHODS IN ANTHROPOLOGY (3)
- 409. ANALYTIC METHODS LABORATORY (1)
- 410. OSTEOLOGY LABORATORY (1)
- 414. SYSTEMATIC INSTRUCTION IN ANTHROPOLOGY (3)
- 415. (Ed.Th.P. 415) ANTHROPOLOGY OF EDUCATION (3)
- 420. ARCHAEOLOGY OF THE NEAR EAST (3)
- 421. ARCHAEOLOGY OF THE CENTRAL ANDES (3)
- 422. ARCHAEOLOGY OF MESO-AMERICA (3)
- 423. ARCHAEOLOGY OF EASTERN UNITED STATES (3)
- 424. ARCHAEOLOGY OF AFRICA (3)
- 440. SOUTH AMERICAN TRIBAL SOCIETIES (3)
- 441. ETHNOLOGY OF THE ANDEAN REGION (3)
- 442. EUROPEAN PEASANTRY (3)
- 444. ETHNOLOGY OF MESO-AMERICA (3)
- 446. ETHNOLOGY OF NORTH AMERICA (3)
- 447. ETHNOLOGY OF SUB-SAHARAN AFRICA (3)



448. ETHNOLOGY OF THE MIDDLE EAST (3)
  449. ETHNOLOGY OF SOUTHEAST ASIA (3)
  450. COMPARATIVE SOCIAL ORGANIZATION (3)
  451. ECONOMIC ANTHROPOLOGY (3)
  453. (Soc. 453) PRIMITIVE RELIGION (3)
  454. POLITICAL ANTHROPOLOGY (3)
  455. CULTURE AND PERSONALITY (3)
  456. CULTURAL ECOLOGY (3)
  457. LANGUAGE IN CULTURE (3)
  458. PRIMATE SOCIOBIOLOGY (3)
  460. ANTHROPOLOGICAL THEORY (3)
  461. METHODS IN CULTURAL ANTHROPOLOGY (3)
  462. METHODS IN ARCHAEOLOGY (3)
  464. TRIBAL SOCIETIES (3)
  471. HISTORY OF ANTHROPOLOGICAL THEORY (3)
  496. INDEPENDENT STUDIES (1-12)
  497. SPECIAL TOPICS (1-6)
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500. HUMAN EVOLUTION (3) Theoretical problems in analysis of human evolution. Prerequisite: one course in human genetics or physical anthropology.
  501. EVOLUTION OF HUMAN BEHAVIOR (3) The application of evolutionary theory to the study of man's structure, function, and culture. Prerequisites: Anthy. 21 or 401, and 3 additional credits in anthropology, sociology, or psychology.
  502. HUMAN ECOLOGY THEORY (3) Analysis of interaction of physical, biological, and cultural factors in human adaptation. Prerequisite: 3 credits in physical anthropology.
  504. SOCIAL AND CULTURAL CHANGE (3) Theories and methods used in the analysis of social and cultural change.
  505. TOPICS IN PRIMATE SOCIOBIOLOGY (3) An advanced seminar on current research and problems in the study of nonhuman primate behavior and ecology. Prerequisite: Anthy. 458.
  506. CULTURAL DYNAMICS (3) Survey of the major theories of culture change with special reference to archaeological research.
  507. THE BIOLOGY OF HUMAN ADAPTABILITY (3) An exploration of the biological mechanisms which aid man's survival in a variety of environmental settings.
  508. RESEARCH PROBLEMS IN CULTURE HISTORY (3-9)
  509. SEMINAR IN REGIONAL STUDIES (3-9) Research and analysis in selected world cultural areas, including ecology, prehistory, history, ethnography, and current status.
  511. (Hl.Ed. 511) HEALTH IMPLICATIONS IN THE GROWTH AND DEVELOPMENT OF SCHOOL CHILDREN (3) Child growth and development emphasis for teachers; medical inspection and examination; preschool program; early habit formations; behavior problems.
  513. (Hl.Ed. 513) HEALTH IMPLICATIONS IN MATURITY AND AGING (3) Changes in the human body in maturity and aging; mechanisms of physiologic aging; implications for health and preventive medicine. Prerequisite: Hl.Ed. 511.
  - 522-523. ECOLOGICAL THEORY IN ANTHROPOLOGY (3 each) Man's biology, culture history, and culture variation from the ecological perspective. Two-term enrollment required. Prerequisite: 6 credits in anthropology.
  530. INDIVIDUAL READINGS IN ANTHROPOLOGY (1-6) Reading or research in selected aspects of general anthropology.
  531. INDIVIDUAL RESEARCH IN ANTHROPOLOGY (3-12)
  545. SEMINAR IN ANTHROPOLOGY (1-9) Critical analysis of research in selected areas of anthropology.

- 558. EVOLUTION OF SOCIAL STRUCTURES I (3) Evolution of social organization. Biological and social changes differentiating human and primate societies.
- 559. EVOLUTION OF STRUCTURES II (3) Major anthropological approaches to study of social organization.
- 560. ANTHROPOLOGICAL THEORY (3) Theory used in culture — historical, sociological, and psychological interpretations.
- 561. FIELD METHODS IN ANTHROPOLOGY (3-9) Individual field work in any aspect of anthropology, supervised by staff of professional rank.
- 562. LABORATORY METHODS IN ANTHROPOLOGY (3-9) Supervised laboratory research, utilizing materials from physical anthropology or archaeology or cultural anthropology.
- 563. SEMINAR IN LINGUISTIC ANTHROPOLOGY (3-6) Organized research on special topics in linguistic anthropology.
- 597. SPECIAL TOPICS (1-6)

## ARCHITECTURAL ENGINEERING (A E)

GIFFORD H. ALBRIGHT, *Head of the Department*  
 104 Engineering A Building  
 814-865-6394

*Degree Conferred:* M.S.

*Graduate Faculty:* Senior Members Summers and Tichy.

*Graduate Faculty:* Associate Members Albright, Geschwindner, and Gilman.

Students may specialize in structural analysis and design, environmental control engineering (including energy conservation and energy management in building), solar energy applications, illumination, acoustics, materials of construction, building construction management, computer application to building design and performance.

For admission a student must have a strong background in some field of engineering; in engineering science or mechanics; or in architecture, psychology, economics, or management if there is adequate preparation in the physical sciences and mathematics. The detailed requirements depend upon the student's area of special interest.

Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

## ARCHITECTURAL ENGINEERING (A E)

- 401. STRUCTURAL DESIGN OF BUILDINGS (3)
- 402. STRUCTURAL DESIGN OF BUILDINGS (3)
- 403. STRUCTURAL DESIGN OF BUILDINGS (3)
- 430. INDETERMINATE STRUCTURES (3)
- 431. STRUCTURAL DESIGN OF BUILDINGS (3)
- 439. MODERN STRUCTURAL SYSTEMS (3)
- 441. INTEGRATION OF ARCHITECTURAL ENGINEERING SYSTEMS (3)
- 454. ADVANCED HEATING, VENTILATING, AND AIR CONDITIONING (3)
- 455. ADVANCED HEATING, VENTILATING, AND AIR CONDITIONING SYSTEM DESIGN (3)
- 456. SOLAR ENERGY BUILDING SYSTEM DESIGN (3)
- 458. ADVANCED ARCHITECTURAL ACOUSTICS AND NOISE CONTROL (3)
- 461. BASIC THEORY OF BUILDING ILLUMINATION (3)
- 464. ADVANCED ARCHITECTURAL ILLUMINATION SYSTEMS DESIGN (3)



- 471. BUILDING CONSTRUCTION ASSEMBLIES (3)
- 472. BUILDING CONSTRUCTION MANAGEMENT I (3)
- 473. BUILDING CONSTRUCTION MANAGEMENT (3)
- 474. BUILDING CONSTRUCTION ESTIMATING (3)
- 475. BUILDING CONSTRUCTION ENGINEERING I (3)
- 476. BUILDING CONSTRUCTION ENGINEERING II (3)
- 477. SENIOR BUILDING CONSTRUCTION PROJECT (3)
- 481. COMPREHENSIVE ARCHITECTURAL ENGINEERING SENIOR PROJECT (2)
- 482. COMPREHENSIVE ARCHITECTURAL ENGINEERING SENIOR PROJECT (3)
- 483. COMPREHENSIVE ARCHITECTURAL ENGINEERING SENIOR PROJECT (2)
- 486. PROFESSIONAL ENGINEERING PRACTICE (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

542. ADVANCED PROBLEMS AND RESEARCH IN ARCHITECTURAL ENGINEERING (2-12) Investigation, analysis, and preparation of comprehensive report on subject relating to special problems in architectural engineering systems.

545. ARCHITECTURAL ENGINEERING SEMINAR (1-6) Current literature and special problems in architectural engineering; presentation of technical papers.

## ARCHITECTURE (ARCH)

RANIERO CORBELLETTI, *Head of the Department*  
 308 Sackett Building  
 814-865-9535

*Degrees Conferred:* M.S., M.Arch.

*Graduate Faculty:* Senior Members Corbelletti, Golany, and Strumillo.

*Graduate Faculty:* Associate Members Anderson, Inserra, Shirvani, and Vollmer.

The Master of Science is an academic degree available to students with training in other design-related fields, as well as to students with a professional degree in architecture reentering the University for study in a speciality. Advanced studies are offered in architecture, urban design, and planning. The student is offered opportunity for independent research and extensive interdisciplinary work under the guidance of specialists and scholars in technical, cultural, industrial, and social fields. The nonthesis option is available for the M.S.degree.

The Master of Architecture degree program is planned to provide the depth and breadth of knowledge needed to enter the architectural profession and become licensed as a professional architect after the required period of internship. Requirements for admission include the equivalent of 39 credits in design-research work and a statement of purpose concerning the professional aims of the candidate. A portfolio of examples of the student's work must be presented. The nonthesis option is available for the M.Arch. degree. The program is available to candidates holding a B.A. or B.S. degree with a major in architecture, or environmental design, or holding other nonprofessional degrees in architecture.

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

## ARCHITECTURE (ARCH)

- 430. DESIGN-RESEARCH II (4-12)
- 441. ARCHITECTURAL DESIGN ANALYSIS (3)
- 442. ARCHITECTURAL DESIGN ANALYSIS (3)

- 443. ARCHITECTURAL DESIGN ANALYSIS (3)
  - 461. ARCHITECTURAL STRUCTURAL SYSTEMS I (3)
  - 462. ARCHITECTURAL STRUCTURAL SYSTEMS II (3)
  - 463. ARCHITECTURAL STRUCTURAL SYSTEMS III (3)
  - 465. ARCHITECTURAL BUILDING MATERIALS (3)
  - 471. ENVIRONMENTAL CONTROL SYSTEMS I (3)
  - 472. ENVIRONMENTAL CONTROL SYSTEMS II (3)
  - 481. ADVANCED ARCHITECTURAL DATA SYSTEMS I (3)
  - 482. ADVANCED ARCHITECTURAL DATA SYSTEMS II (3)
  - 483. SPECIAL PROBLEMS — ARCHITECTURAL DATA SYSTEMS APPLICATIONS (3)
  - 496. INDEPENDENT STUDIES (1-12)
  - 497. SPECIAL TOPICS (1-6)
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- 510. URBAN DESIGN POLICY AND IMPLEMENTATION (3) Analysis of urban design: origins, function, accomplishments; examination of urban design policy and of problems encountered in various cities.
  - 515. NEW TOWNS PLANNING SEMINAR (3) Examination of the process, concepts, and structure of new towns planning as a response to contemporary urban-regional development problems.
  - 516. NEW COMMUNITIES SEMINAR (3) Examination and evaluation of the new communities movement in the United States.
  - 517. NEW TOWNS PLANNING PROCESS (3) A systematic study and analysis of the sequence of actions in the new towns planning process.
  - 518. NEW TOWNS RESEARCH SEMINAR (3) Advanced research seminar using comparative case studies of comprehensive contemporary issues of new towns planning. Prerequisites: Arch. 515, 517.
  - 530. ARCHITECTURE I (4-12) Problems in architectural planning and design. Programming and/or implementation methodologies and applications for various environmental design scales.
  - 531. ARCHITECTURE II (4-12) Continuation of Arch. 530 with concentration and specialization options. Prerequisite: Arch. 530.
  - 532. COMPREHENSIVE PLANNING PROCESS STUDIO (4-12) Field case studies in analysis forecasting and projections of urban physical design elements. Preparation of comprehensive plan, regulations, and implementation.
  - 535. NEW TOWNS PLANNING STUDIO (4-12) A team workshop of planning and design of new towns, involving data gathering, surveys, analysis, projection, and implementation.
  - 591. ARCHITECTURAL RESEARCH (2-12) Guided research project.
  - 596. INDIVIDUAL STUDIES (1-6)
  - 597. SPECIAL TOPICS (1-6)

## ART (ART)

JERROLD MADDOX, *Director, School of Visual Arts*  
 102 Visual Arts Building  
 814-865-0444

*Degrees Conferred:* M.A., M.F.A.

*Graduate Faculty:* Senior Members Adams, Cook, DonTigny, Frost, Shobaken, and Zoretich.

*Graduate Faculty:* Associate Members Hanson, Hessel, Lang, Mayhew, McHale, Porter, Sommesse, and Stephenson.

The M.A. program is planned to provide a broad range of experience and study in the visual arts. A thesis in an area of specialization is required. Requirements for admission include a broad undergraduate training in art and the presentation of a portfolio of the applicant's work.



The M.F.A. program is planned to provide professional emphasis in a specific area of art. A creative project and supporting monograph are required. Requirements for admission include 36 credits in studio art with some indication of concentration in a chosen area and a statement of purpose concerning the professional aims of the candidate. A portfolio must be presented.

A portfolio of slides (quality photographs for sculpture applicants), rather than actual work, is requested. A selection of no fewer than twenty examples should be presented. The majority of these should be in the area of the applicant's interest, but the portfolio should also include a lesser emphasis in related areas.

All students accepted for graduate study in art who lack the adequate undergraduate courses or show deficiencies in some area will be required to take additional course work without degree credit.

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

## ART (ART)

- 411. SEMINAR IN CONTEMPORARY ART (3 per term, maximum of 6)
- 421. ADVANCED DRAWING (3 per term, maximum of 9)
- 425. DRAWING SEMINAR (3 per term, maximum of 6)
- 430. ADVANCED SCULPTURE (3 per term, maximum of 12)
- 448. ADVANCED PRINTMAKING (3 per term, maximum of 12)
- 450. ADVANCED PAINTING (3 per term, maximum of 12)
- 455. ADVANCED PAINTING CRITIQUE (3 per term, maximum of 6)
- 460. ADVANCED WATERCOLOR (3 per term, maximum of 12)
- 465. ADVANCED DESIGN (3 per term, maximum of 9)
- 470. TIME AND SEQUENCE (3)
- 471-472. SENIOR PROBLEMS (3 each)
- 473. GRAPHIC DESIGN SEMINAR (3)
- 480. ADVANCED CERAMIC ARTS (3 per term, maximum of 12)
- 491. PHOTOGRAPHY AND OTHER DISCIPLINES (3 per term, maximum of 12)
- 492. CREATIVE PROJECTS IN PHOTOGRAPHY (3 per term, maximum of 12)
- 494. GROUP PROJECTS IN PHOTOGRAPHY (3 per term, maximum of 9)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 501. ART RESEARCH (2-6) Original study and practice in art relating to material, concept, or technique.
- 530. ADVANCED SCULPTURE (3-12) Individual projects in sculpture leading to the development of a collection or body of work representative of the artist.
- 545. PRINTMAKING (2-12) Problems in printmaking leading to the development of a collection or body of work representative of the individual artist.
- 550. PAINTING (2-12) Individual problems in painting leading to the development of a collection or body of work representative of the artist.
- 570. DESIGN (2-12) Individual projects in design with special emphasis on professional practice in specialized fields of graphic design.
- 580. CERAMICS (2-12) Experimental problems in ceramics leading to the development of a collection or body of work representative of the individual.
- 595. PHOTOGRAPHY (3) Individual projects in photography leading to the development of a body of specialized work representative of the artist. Prerequisite: 12 credits of Art 495.

## ART EDUCATION (A ED)

KENNETH R. BEITTEL, *In Charge of Graduate Programs in Art Education*  
268 Chambers Building  
814-865-5601

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Senior Members Beittel, Bradley, Hoffa, Ott, Schwartz, Van Dommelen, and Wilson.

*Graduate Faculty:* Associate Member Anderson.

This program prepares students for careers in public school art teaching, art supervision, college teaching, administration, or research. To be admitted without deficiencies, the student is expected to have completed either a baccalaureate program in art education or a program leading to certification. Such a program would include work in art studio, art history, art education, education, educational psychology, and psychology. Deficiencies may be made up by course work which is not counted as credit toward an advanced degree.

All students are expected to complete two years of teaching before receiving the doctoral degree. A foreign language is not required of all Ph.D. degree candidates. In lieu of a foreign language, students will include a series of research and communications studies pertinent to their interests and to their graduate programs and may include a foreign language approved by the doctoral committee.

Students with a 2.75 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.75 grade-point average may be made for students with special backgrounds, abilities, and interests. Transcripts should indicate high attainment in appropriate academic and creative work, and recommendations should attest to scholarship and ability to work independently. Creative work, as shown by slides and photographs, should show a high level of involvement and sensitivity to aesthetic-forming processes.

Students who seek admission to the graduate program must make formal application to the admissions committee of the art education program.

## ART EDUCATION (A ED)

- 404. METHODS OF GRAPHICS AND ILLUSTRATIONS (3)
- 414. ADVANCED CRAFTS FOR TEACHERS (3-6)
- 415. FIBER CRAFTS IN EDUCATION (3)
- 417. METAL CRAFTS IN EDUCATION (3)
- 420. CERAMICS FOR TEACHERS (3)
- 434. ART APPRECIATION IN THE EDUCATIONAL PROGRAM (3)
- 435. ART IN THE ELEMENTARY SCHOOL (3)
- 436. ART IN THE SECONDARY SCHOOL (3)
- 437. PROFESSIONAL TERM IN ART EDUCATION (10)
- 486. CURRENT PROBLEMS IN ART EDUCATION (2-3)
- 487. MURAL PAINTING IN SCHOOLS (3)
- 488. ADVANCED MURAL PAINTING IN SCHOOLS (3)
- 489. ART EXPERIENCES WITH CHILDREN (3)
- 490. INTRODUCTION TO RESEARCH IN ART EDUCATION (3)
- 494. SCHOOLS AND MUSEUMS (3)
- 495. INTERNSHIP IN ART EXPERIENCES (12)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

501. SEMINAR IN ART EDUCATION (1-6) The analysis of fundamental concepts derived from related disciplines; the examination of current problems; current literature.

504. ADVANCED METHOD IN GRAPHIC PROCESSES (3) Exploration through laboratory experience of printing method: etching, silk screen, linoleum, or other; applications in teaching.



514. **FUNCTIONAL RELATIONSHIPS IN CRAFTS (3)** Relationships of material design and purpose in crafts discussed by means of outstanding products of different materials, periods, and cultures. Prerequisite: 6 credits in crafts, or 3 in design and 3 in advanced crafts.
516. **ANALYSIS OF THREE-DIMENSIONAL PROCESSES IN ART (3)** Three-dimensional processes analyzed with regard to kinetic, textural, form, and other functions.
520. **ADVANCED CERAMIC ART (3)** Intensified exploration of throwing, glazing, and firing processes as related to aesthetic considerations in contemporary art forms and past cultures. Prerequisite: A.Ed. 420.
535. **ADMINISTRATION AND SUPERVISION OF ART EDUCATION PROGRAMS (3)** The problems and responsibilities of the city, county, and state art supervisor; curriculum, facilities, financing, supervision, in-service training, and reporting. Prerequisites: A.Ed. 435, 436.
536. **CURRICULUM DEVELOPMENT IN ART EDUCATION (3)** Factors affecting art curriculum decisions, analysis, selection, organization, preparation of curriculum. Evaluation and sources of art curriculum improvement and innovation. Prerequisite: 6 credits of methods.
541. **THEORIES OF CHILD ART (3)** Study of current theories of child art; application of recent psychological and anthropological theories to understanding child art. Prerequisite: A.Ed. 486 or 501.
545. **EVALUATION AND ASSESSMENT IN ART EDUCATION (3)** Study of theories of evaluation; application of judgmental criteria; analysis and construction of assessment instruments and scoring procedures. Prerequisites: A.Ed. 490, 501.
588. **HISTORY OF ART EDUCATION (3)** Historical development of philosophies in art education in the United States and abroad.
589. **RESEARCH METHODS IN ART EDUCATION (3-6)** Orientation in research methods; findings and designs related to the study of problems in art education.
595. **RESEARCH IN ART EDUCATION (1-6)** Independent research, under an adviser, to be terminated by a scholarly report proportionately comparable in quality to a master's thesis. Prerequisite: 15 credits in art education at the 400 and 500 levels, including A.Ed. 589.
602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)**

## ART HISTORY (ART H)

HELLMUT W. HAGER, *Head of the Department*  
229 Arts II Building  
814-865-6326

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Senior Members Battisti, Chenault-Porter, Cutler, Fleischer, Hager, Henisch, Kiang, and Maurer.

Graduate work is offered in the following areas: ancient art, medieval and Byzantine art, Renaissance and baroque art, and modern art. Special research opportunities are available through the Center for the Study of Renaissance and Baroque Art.

Candidates for the M.A. degree are required to complete a master's thesis and to demonstrate a reading knowledge of two foreign languages, one of which must be German. The other language is normally French or Italian. Reading knowledge of one of these languages must be demonstrated before the end of four terms of study. These regulations apply equally to Ph.D. students. For those students wishing to enter the doctoral program who have already completed a master's degree from another university, a reading knowledge of one foreign language will be required before the student can be considered for admission to the department.

Candidates with a 3.00 junior-senior grade-point average and a minimum of 21 credits in art history will be considered for admission to the master's program. Lacking these, a promising candidate may be accepted on condition that deficiencies be remedied, but without graduate degree credit. The best-qualified applicants will be accepted up to the number of spaces that are available for new students.

**ART HISTORY (ART H)**

401. STUDIES IN GREEK ART (3)
  402. THE ILLUMINATED MANUSCRIPT (3)
  404. THE ART OF COLONIAL AMERICA (3)
  405. PIONEERS OF MODERN ARCHITECTURE (3-6)
  410. TASTE AND CRITICISM IN ART (3)
  411. ART OF IMPERIAL ROME (3)
  412. THE GOTHIC CATHEDRAL (3)
  414. STUDIES IN ITALIAN BAROQUE ART (3-9)
  415. THE SKYSCRAPER (3)
  416. AMERICAN PAINTING: 1876-1913 (3)
  422. STUDIES IN MEDIEVAL SCULPTURE (3)
  423. STUDIES IN ITALIAN RENAISSANCE ART (3-9)
  424. MASTERS OF NORTHERN BAROQUE ART (3)
  425. MOVEMENTS IN NINETEENTH-CENTURY ART (3)
  430. GOYA AND HIS TIMES (3)
  432. PROBLEMS IN ICONOLOGY (3)
  435. MOVEMENTS IN TWENTIETH-CENTURY ART (3-6)
  443. PROBLEMS IN BYZANTINE ART (3)
  450. THE HISTORY OF PHOTOGRAPHY (3)
  451. SURVEY OF SPANISH BAROQUE PAINTING (3)
  452. PAINTING IN THE AGE OF LOUIS XIV (3)
  456. GIAN LORENZO BERNINI AND THE ARCHITECTURE OF THE FULL BAROQUE IN ROME (3)
  458. ROMAN ROCOCO ARCHITECTURE AND THE DAWN OF NEOCLASSICISM (3)
  496. INDEPENDENT STUDIES (1-12)
  497. SPECIAL TOPICS (1-6)
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510. STUDIES IN ART HISTORY (3-6 per term) Original investigation in art history, to be pursued independently or concurrently with course work in particular fields.
  511. SEMINAR IN ANCIENT ART (3-12) Selected topics from the history of Greek and Roman art.
  512. SEMINAR IN MEDIEVAL ART (3-12) Original research into problems dealing with the art of the Middle Ages.
  513. SEMINAR IN RENAISSANCE ART (3-12) Investigations in the area of Renaissance art, centering around major masters and monuments.
  514. SEMINAR IN BAROQUE ART (3-12) Investigations in the area of baroque art, centering around major masters and monuments.
  515. SEMINAR IN MODERN ART (3-12) Lectures, readings, reports, and discussions in the field of modern art.
  517. SEMINAR IN EIGHTEENTH-CENTURY ART (3-12) Investigation into themes and problems dealing with eighteenth-century art.
  520. SEMINAR IN SPANISH BAROQUE PAINTING (1-6) Specific problems in the history of seventeenth-century Spanish painting.
  522. SEMINAR IN BYZANTINE ART (3-12) Specific iconographical and stylistic problems in Byzantine art and its relation to classical antiquity, the medieval West, and Islam.
  525. SEMINAR IN MODERN ARCHITECTURE (3-12) Investigation into the works and problems of modern architecture as they relate to the culture of our times.
  542. THE ILLUSTRATION OF THE APOCALYPSE (3- 6) Studies in the illustration of the Apocalypse, iconographical and stylistic, from the early Christian period through Dürer.
  551. HISTORIOGRAPHY OF ART HISTORY (1-6) The relationship between the definition of, and approach to, art-historical problems from Vasari to the present.



552. **PROBLEMS IN CONNOISSEURSHIP (3)** A study of the problems of authenticating, attributing, and dating paintings and sculpture through internal evidence.
555. **ART HISTORY FIELD SEMINAR (3-12)** Investigations based on the site study of specific art objects, with trips in successive years to different art centers.
596. **INDIVIDUAL STUDIES (1-6)**
597. **SPECIAL TOPICS (1-6)**

## ASTRONOMY (ASTRO)

SATOSHI MATSUSHIMA, *Head of the Department*  
 525 Davey Laboratory  
 814-865-0418

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Auer, Garmire, Matsushima, Sampson, Usher, and Weedman.

*Graduate Faculty:* Associate Members Baan, Page, Ramsey, and Winkler.

Graduate instruction and research opportunities are available in both theoretical and observational astronomy and astrophysics. Currently active areas of theoretical research include atomic processes and radiative transfer, plasma astrophysics, theory of stellar atmospheres, interstellar medium, gaseous nebulae, mass loss and other problems related to fluid flow, galactic structure, high-energy astrophysics, and relativity and cosmology. Observational areas include spectroscopic, photometric, and radio frequency observations of quasars and galaxies; high-resolution spectroscopy of early- and late-type stars, peculiar stars, variable stars, white dwarfs, and stellar flare phenomena; satellite observations of ultraviolet and X-ray spectra of stars and galactic sources; X-ray data from HEAO-1 and the Einstein Observatory on galactic and extragalactic X-ray sources and the diffuse X-ray background; sounding rocket and satellite instrumentation of X-ray and EUV telescopes and detectors; and electronic and computer instrumentation.

The center of observational research facilities is the Penn State Black Moshannon Observatory, located twenty-five miles northwest of the University Park Campus. Basic instruments are telescopes of 1.6m and 0.6m aperture and a variety of spectrographs and photometers equipped with modern detectors and data acquisition systems. Supplementing the local facilities, national facilities such as Kitt Peak, Cerro Tololo, Sacramento Peak, and Hale, Arecibo, and National Radio Astronomy observatories, as well as satellite observatories are used by Penn State faculty and graduate students.

Modern astronomy has very close ties with mathematics, physics, and engineering. The program required of a doctoral candidate normally includes some courses in these related fields, in addition to those in astronomy. Proficiency in French, German, or Russian is required. A knowledge of computer programming may be substituted for this foreign language requirement. A nonthesis option is available for the M.S. degree.

Applicants with a bachelor's degree in astronomy or an allied field such as physics, mathematics, or geophysics are given equal consideration for admission. Opportunity to make up possible undergraduate deficiencies is provided. GRE scores, including the advanced test, and a grade-point average of 3.00 or better for junior-senior courses in astronomy and related subjects is necessary for consideration for admission. Exceptions to this minimum requirement may be made for students with special backgrounds, abilities, and interests.

## ASTRONOMY (ASTRO)

430. **GENERAL ASTRONOMY FOR TEACHERS (3)**
440. **INTRODUCTION TO ASTROPHYSICS (3)**
450. **PRACTICAL ASTRONOMY (3)**
460. **FUNDAMENTALS OF CELESTIAL MECHANICS (3)**

- 470. SOLAR PHYSICS (3)
- 480. NEBULAE, GALAXIES, AND COSMOLOGY (3)
- 485. INTRODUCTION TO HIGH-ENERGY ASTRONOMY (3)
- 492. (E.E. 492) SPACE ASTRONOMY AND INTRODUCTION TO SPACE SCIENCE (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 510. ASTROPHYSICS I (3) The theory of atomic structure and spectra and the theory of equilibrium statistical mechanics with applications to astrophysical plasmas. Prerequisite: Astro. 410.
- 511. ASTROPHYSICS II (3) The theory of atomic processes and radiative transfer with and without the assumption of local thermodynamic equilibrium. Applications to astrophysics.
- 513. OBSERVATIONAL TECHNIQUES IN ASTRONOMY (3) Theoretical and practical aspects of modern observational astrophysics. Photometry, spectroscopy, stellar classification, detectors, space astronomy, and basic information theory. Prerequisite: Astro. 490.
- 514. OBSERVATIONAL PRACTICE (1-3) Practical experience with the observational research facilities, and with techniques of data acquisition and reduction.
- 524. CELESTIAL MECHANICS AND SPHERICAL ASTRONOMY (3) Two-body and one-body theory, elliptic motion, expansions, two-body orbit in space, coordinate transformations, planetary equations. Lagrange and Hamilton mechanics. Prerequisite: Astro. 460.
- 530. THEORY OF STELLAR ATMOSPHERES (3) Theory of photospheric structure, radiative processes, and line-formation in the outer layers of stars, and interpretation of stellar spectra. Prerequisite: Astro. 510.
- 531. THEORY AND ANALYSIS OF SPECTRAL LINES (3) The formation of spectral lines for both the LTE and NLTE cases, analysis of both line profiles and integrated intensities. Prerequisite: Astro. 530.
- 534. STELLAR STRUCTURE AND EVOLUTION (3) Theory of physical processes, structure, and evolutionary changes of stars; nature of intrinsic variable stars; the Hertzsprung-Russell diagram. Prerequisite: Astro. 510 or Phys. 561.
- 542. GASEOUS NEBULAE AND INTERSTELLAR MATTER (3) Theory and observations of galactic nebulae and interstellar medium, and problems related to the formation of stars. Prerequisite: Astro. 510.
- 550. HIGH-ENERGY ASTROPHYSICS (3) Theory and observations of X-rays and gamma rays from stars, black holes, neutron stars, supernova remnants, and extragalactic objects. Prerequisites: Phys. 400; 410 or 454.
- 582. RADIO ASTRONOMY (3) Methods of radio astronomy and its contribution to modern astrophysics. Galactic and extragalactic sources, using line, continuum, and interferometric observations. Prerequisite: Astro. 490.
- 583. GALAXIES, QUASARS, AND COSMOLOGY (3) Structure and population of the Milky Way galaxy, properties of galaxies, properties and nature of quasars, distance scale, and deceleration parameter. Prerequisite: Astro. 582.
- 590. COLLOQUIUM (1-3) Continuing seminars which consist of a series of individual lectures by faculty, students, or outside speakers.
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)



## BIOCHEMISTRY (BIOCH)

M. FRANK MALLETTE, *In Charge of Graduate Programs in Biochemistry*  
206 Althouse Laboratory  
814-865-1227

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Aronson, Bernlohr, Deering, Hammerstedt, Hymer, Karakawa, Mallette, McCarl, Pazur, Phillips, R. Schraer, Shigley, and Wedler.

*Graduate Faculty:* Associate Members Hardison, Johnson, and Tu.

Opportunities for research and graduate study are available in intermediary metabolism, cellular control mechanisms, molecular genetics, enzyme structure, enzyme kinetics and mechanisms, proteins, carbohydrates, lipids, endocrinology, subcellular structures, computer applications, biochemistry of reproduction, heart cell culture, and immunochemistry.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by a reading knowledge of one foreign language which is widely used by biochemists.

Entering graduate students should have had at least one year's work in each of the following: general chemistry, analytical chemistry, organic chemistry, physical chemistry, and general physics. Mathematics through integral calculus is also required. Students with limited deficiencies in these subjects may be admitted but must make up such deficiencies concurrently with their graduate studies. Undergraduate courses in biology, biochemistry, and foreign languages will be helpful to the student but are not required for admission.

Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

## BIOCHEMISTRY (BIOCH)

- 401. GENERAL BIOCHEMISTRY (3)
- 402. GENERAL BIOCHEMISTRY (3)
- 403. EXPERIMENTAL BIOCHEMISTRY (3)
- 417. BIOCHEMICAL METHODS (6)
- 425. INTRODUCTORY PHYSICAL BIOCHEMISTRY (4)
- 437. PHYSIOLOGICAL BIOCHEMISTRY (3)
- 438. PHYSIOLOGICAL METHODS (2)
- 451. SENIOR SEMINAR (1)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 503. BIOCHEMICAL PROBLEMS (1-10 per term) Prosecution of an assigned problem under the guidance of an instructor.
- 507. SEMINAR IN BIOCHEMISTRY (1 per term)
- 514. (M.C.B. 514) MOLECULAR BIOLOGY AND CELLULAR REGULATION (3) Structure, synthesis, and biochemical properties of nucleic acids; protein biosynthesis; control of gene expression; molecular genetics. Prerequisite: Bioch. 402.
- 520. CARBOHYDRATES, LIPIDS, AND THEIR INTEGRATED METABOLISM (3) Chemistry of carbohydrates, lipids, and membranes; interrelationships between lipid and carbohydrate biosynthesis and metabolism. Prerequisite: Bioch. 402.
- 525. PROTEINS AND ENZYMES (3) Properties of proteins and polypeptides, structural analysis and molecular interactions; enzyme structure, kinetic mechanisms, and control. Prerequisite: Bioch. 402.

590. COLLOQUIUM (1-3)

597. SPECIAL TOPICS (1-6)

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## BIOENGINEERING (BIOE)

D. B. GESELOWITZ, *Chairman of the Program Committee in Bioengineering*  
254 Hammond Building  
814-865-1407

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Adams, Anthony, Buskirk, Fonash, Geselowitz, Hollis, Kenney, Kline, Lewis, Michael, Morrow, Munger, Pierce, Sharma, Tarbell, Ultman, Weidner, and Zelis.

*Graduate Faculty:* Associate Members Freivalds, Gaumond, Liedtke, Nellis, and Shung.

This intercollege program is designed to provide the student with graduate-level training in engineering and in the life sciences, and specialized training in specific areas of interaction of engineering with biology and medicine. Graduate instruction in bioengineering is under the direction of a program committee composed of graduate faculty representing several departments.

Opportunities for specialized research include electrical and mechanical properties of biological materials, development of an artificial heart, hemodynamics, electrocardiography, medical imaging, auditory electrophysiology, lung mechanics, bioinstrumentation, transducers, rheology of biological fluids, and ultrasonics.

The particular course of study depends on the student's background and area of research specialization. Courses are selected from the life sciences, engineering, and bioengineering. Candidates for the Ph.D. degree generally are expected to complete Phsio. (Biol.) 571-573 plus several additional courses in the life sciences, five courses in bioengineering, and five graduate-level courses in engineering, mathematics, and physics. Supporting courses are available at University Park and The Milton S. Hershey Medical Center in anatomy, biochemistry, biology, biophysics, chemistry, laboratory animal medicine, materials science, mathematics, physics, physiology, and the engineering departments.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by demonstrating intermediate knowledge of an acceptable foreign language, or by taking an advanced technical writing course and presenting a formal proposal for thesis research to the doctoral committee.

A thesis is required for the M.S. degree. Course requirements include Bioe. 401 and 402 plus two 500-level courses in bioengineering, 6 credits in the life sciences including Biol. 472, and 6 credits in technically oriented courses outside of bioengineering and the life sciences. In addition, students without a previous degree in engineering or physics are required to complete up to 24 additional credits in engineering. Most of this additional course work will be at the undergraduate level, and typically includes statics and dynamics, electric circuits and fields, electronic devices, fluid mechanics, and linear systems.

Students with a degree in engineering, physics, or the life sciences will be eligible for admission. All students must have a strong background in physics and mathematics. This background should include 9 credits in chemistry, 9 credits in physics, and mathematics through calculus and differential equations. Students who lack one or two courses may still be considered for admission but will have to make up any deficiency early in their graduate program. Students with a 2.80 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces available. Exceptions to the minimum grade-point average may be made for students with special backgrounds, abilities, and interests.

## BIOENGINEERING (BIOE)

401. INTRODUCTION TO BIOENGINEERING (3)

402. BIOMEDICAL INSTRUMENTATION AND MEASUREMENTS (3)

425. (Nuc.E. 425) RADIOGRAPHIC IMAGING (3)



496. INDEPENDENT STUDIES (1-12)

497. SPECIAL TOPICS (1-6)

501. BIOENGINEERING TRANSPORT PHENOMENA (3) Application of the equations of mass, energy, and momentum conservation to physiological phenomena and to the design of artificial organs.

502. INTRODUCTION TO BIOELECTRIC PHENOMENA (3) Electric phenomena in nerve and muscle, membrane potentials, Hodgkin-Huxley equations, volume conductor problem, applications to electrocardiography, electroencephalography, plethysmography.

503. FLUID MECHANICS OF BIOENGINEERING SYSTEMS (3) Cardiovascular system and blood flow, non-Newtonian fluid description, vessel flows, unsteady flows and wave motion, windkessel theory, transmission line theory.

504. PHYSIOLOGICAL SYSTEMS ANALYSIS (3) Application of systems theory, control theory, and analytic modeling strategies to the study of physiological systems. Prerequisites: Biol. 472, Engr. 100.

505. BIOENGINEERING MECHANICS (3) Passive and active mechanical properties of tissues, rheological materials, models of muscle contraction, pulmonary mechanics, forces in muscular-skeletal system.

506. MEDICAL IMAGING (3) Medical diagnostic imaging techniques including generation and detection of ultrasound, X-ray, and nuclear radiation; instrumentation and biological effects. Prerequisite: Phys. 202.

570. TOPICS IN BIOMEDICAL INSTRUMENTATION (1) Physiological basis, theory of operation, and practical aspects of clinical instrumentation.

580. BIOENGINEERING INTERNSHIP (3-6) Supervised experience at The Milton S. Hershey Medical Center including rotation through services and work on a minor project. Prerequisites: Bioe. 402 and 3 credits in bioengineering at the 500 level.

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

## BIOLOGICAL CHEMISTRY (BCHEM)

EUGENE A. DAVIDSON, *Chairman of the Department*  
The Milton S. Hershey Medical Center  
Hershey, PA 17033  
717-534-8585

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Davidson, Hass, Hill, Miljkovic, Schengrund, and Shiman.

*Graduate Faculty:* Associate Members Bhavanandan, A. Hopper, J. Hopper, and Rose.

Opportunities for research and graduate study are available in the chemistry and metabolism of complex polysaccharides, cellular differentiation, mechanism of enzymatic reactions, biochemical genetics, biochemistry of complex lipids, conformational analysis of carbohydrates and proteins, natural product chemistry, and physical chemistry of macromolecules.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of one foreign language. The nonthesis option is available for the M.S. degree.

Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. Interested students should contact the department chairman.

The program is offered only at The Milton S. Hershey Medical Center.

**BIOLOGICAL CHEMISTRY (BCHEM)**

502. **BIOLOGICAL CHEMISTRY I (3)** Structure-function relationships of macromolecules; pathways utilized for energy generation in mammalian systems; concepts of metabolic regulation. Concurrent: Micrb. 556.

503. **NUCLEIC ACID BIOCHEMISTRY (2)** Aspects of the mechanism and control of nucleic acid and protein biosynthesis with emphasis on their relationship to genetic phenomena. Prerequisite: Micrb. 556.

505. **BIOLOGICAL CHEMISTRY II (3)** A continuation of B.Chem. 502. Emphasis on interrelations of metabolic pathways, catabolic end products, and regulation. Prerequisites: B.Chem. 502; Micrb. 556.

513. **BIOLOGICAL CHEMISTRY, MACROMOLECULES (3)** Physical chemistry of macromolecules; techniques for investigating conformations, size, and interactions. Development and application of thermodynamics to solutions of macromolecules.

523. **METABOLISM (3)** Molecular mechanisms employed by living systems to transform biological compounds, control production and utilization of energy, and regulate metabolic pathways.

551. **KINETICS AND MECHANISM OF ENZYME ACTION (3)** Current kinetic theory, rapid reactions, regulatory enzymes, chemical and physical approaches to the study of the mechanism of enzyme action. Prerequisite: B.Chem. 502. Concurrent: B.Chem. 523.

553. **BIOCHEMICAL TECHNIQUES (3)** Lectures and discussion on approaches to macromolecule and lipid separation and characterization; isolation of subcellular organelles; enzymatic assay; radioisotopes. Prerequisite: B.Chem. 502.

590. **COLLOQUIUM (1-3)**

596. **INDIVIDUAL STUDIES (1-6)**

597. **SPECIAL TOPICS (1-6)**

**BIOLOGY (BIOL)**

E. S. LINDSTROM, *Head of the Department*  
208 Erwin W. Mueller Building  
814-865-4562

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Anthony, Bellis, Cooper, Dunson, Fergus, Graves, Grun, Hamilton, Hibbard, Hillson, Hollis, Keener, MacCluer, Pearson, Pursell, Schein, Spackman, Therrien, Traverse, Wickersham, Williams, and Wright.

*Graduate Faculty:* Associate Members Burris, Gregg, Mitchell, Neff, Petters, Stephenson, and Turpen.

The department will direct graduate programs in behavior, cell biology, cytology, cytochemistry, environmental science, ultrastructure, and other aspects of modern biology. The courses of study are planned individually by the student and an adviser. The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of one foreign language. Candidates have the option of a thesis or a paper for the M.S. degree.

Admission is restricted to students who have the baccalaureate degree in a biological science and who present a cumulative undergraduate average of at least 3.00. Each applicant must provide scores from the Graduate Record Examination, a personal statement of interests and objectives, and letters from two persons verifying the applicant's academic competence.

**BIOLOGY (BIOL)**

402. **VERTEBRATE NEUROANATOMY (3)**

407. **PLANT ANATOMY (3)**



409. BIOLOGY OF AGING (3)
  414. TAXONOMY OF SEED PLANTS (3)
  417. INVERTEBRATE ZOOLOGY (4)
  418. MYCOLOGY (3)
  420. (Geosc. 420) PALEOBOTANY (3)
  421. COMPARATIVE ANATOMY OF VERTEBRATES (4)
  422. ADVANCED GENETICS (3)
  423. (Geosc. 423) INTRODUCTORY PALYNOLOGY (3)
  426. INTRODUCTORY CYTOGENETICS (3)
  427. (Geosc. 427) EVOLUTION (3)
  428. POPULATION GENETICS (3)
  429. DEVELOPMENTAL GENETICS (3)
  431. COMPARATIVE PLANT MORPHOLOGY (2)
  432. LABORATORY IN COMPARATIVE PLANT MORPHOLOGY (2)
  433. TERRESTRIAL ECOLOGY (3)
  434. TERRESTRIAL ECOLOGY LABORATORY (2)
  435. ECOLOGY OF LAKES AND STREAMS (3)
  436. FRESHWATER ECOLOGY RESEARCH TECHNIQUES (3)
  437. HISTOLOGY (4)
  438. ORNITHOLOGY (2)
  439. ORNITHOLOGY LABORATORY (2)
  440. EMBRYOLOGY (4)
  441. PLANT PHYSIOLOGY (3)
  442. PLANT PHYSIOLOGY (3)
  445. PHYTOHORMONES (3)
  446. PHYSIOLOGICAL PLANT ECOLOGY (2)
  452. ICHTHYOLOGY (3)
  454. HERPETOLOGY (2)
  460. EMBRYONIC DIFFERENTIATION (3)
  464. (An.Sc. 464) ANIMAL BEHAVIOR — SOCIOBIOLOGY (3)
  465. GENERAL CYTOLOGY (3)
  466. LABORATORY IN CYTOLOGY (1)
  467. CYTOCHEMICAL METHODS (3)
  472. MAMMALIAN PHYSIOLOGY (3)
  473. LABORATORY IN MAMMALIAN PHYSIOLOGY (2)
  477. BIOLOGY OF HUMAN SEXUALITY (3)
  478. BIOLOGICAL AND MEDICAL ASPECTS OF THE MAMMARY GLAND (2)
  479. GENERAL ENDOCRINOLOGY (3)
  482. COASTAL BIOLOGY (4)
  496. INDEPENDENT STUDIES (1-12)
  497. SPECIAL TOPICS (1-6)
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502. THE PHYSIOLOGY OF THE FUNGI (3) Chemical composition, metabolism, toxic and stimulating agencies, spore germination, growth and irritability of the fungi. Fall term, even years.
  504. (M.C.B. 504) SEMINAR IN CELL BIOLOGY (1) Discussion of current problems and ideas in cell biology with emphasis on reference to recent literature.
  506. COMPARATIVE ANATOMY OF VASCULAR PLANTS (3) Structure of the Tracheophyta from a phylogenetic standpoint. Prerequisite: Biol. 407. Spring term, even years.
  511. ADVANCED PLANT PHYSIOLOGY (3) Physiology of plants including uptake of water and minerals, translocations, mineral nutrition, energy relations, respiration and catabolism. Prerequisite: Biol. 442. Fall term.
  512. ADVANCED PLANT PHYSIOLOGY (3) Continuation of Biol. 511. Physiology of plants including photosynthesis, synthesis of cellular constituents, growth and development. Prerequisite: Biol. 442. Winter term.

514. TOPICS IN PLANT SYSTEMATICS AND EVOLUTION (1) Discussion of pertinent current literature in plant biosystematics.
516. TOPICS IN ANGIOSPERM GEOGRAPHY AND EVOLUTION (3) Distribution of plant communities; environmental factors which influence their present distribution; geological-historical development of plant communities, their past distribution. Winter term, odd years.
517. FISH BEHAVIOR AS RELATED TO AQUATIC ECOLOGY (3) Receptor-effector systems, selection of habitat and the effects of behavioral interaction on population levels, growth, and survival. Prerequisite: Biol. 452 or 462.
518. SPECIAL PROBLEMS (1-6) Prosecution of an assigned problem under the guidance of a staff member. Throughout the year as arranged. By appointment.
519. ZOOGEOGRAPHY (3) The present distribution of world vertebrates, their evolution, and their patterns of dispersal in the past.
522. LOWER FUNGI (3) Morphology, taxonomy, phylogeny, and life histories. Prerequisite: Biol. 418. Winter term, even years.
523. HIGHER FUNGI (3) Morphology, taxonomy, phylogeny, and life histories. Prerequisite: Biol. 418. Spring term, even years.
524. SEMINAR IN GENETICS (1 per term)
526. (Geol. 526) PROBLEMS IN PALYNOLOGY (1-6) Individual research projects in various aspects of palynology, especially palynostratigraphy and paleoecological palynology. Prerequisite: Biol. 423.
531. BRYOLOGY (3) Morphology, taxonomy, and ecology of liverworts, hornworts, and mosses; collection, preservation, culturing, and cytologic techniques. Spring term, even years.
533. PROBLEMS IN GENETICS (2-6) Problems to suit needs of individual students; conferences and laboratory work.
535. MORPHOLOGY OF THE TRACHEOPHYTES EXCLUSIVE OF ANGIOSPERMS (3) Origin, developmental tendencies, structure, and paleobotanical evidence. Winter term, odd years.
536. MORPHOLOGY OF ANGIOSPERMS (3) Floral origin and development, fertilization, embryogeny, seeds and fruit development. Prerequisite: Biol. 431.
538. PRINCIPLES OF MICROSCOPIC HISTOCHEMISTRY (2) Theoretical basis for the microscopic identification, localization, and quantitative analysis of chemical substances in tissues of organisms. Prerequisite: Biol. 437 or 465.
539. ANALYTICAL HISTOCHEMISTRY LABORATORY (2-4) Application of histochemical techniques in the microscopic analysis of tissue lipids, proteins, carbohydrates, nucleic acids, and proteins. Prerequisite or concurrent: Biol. 538.
540. PHYCOLOGY (4) Comparative morphology, taxonomy, and ecology of freshwater and marine algae; culturing, collection, preservation techniques.
542. (Ent. 542) SYSTEMATICS (3) Principles and methods of classification, phylogeny, and speciation; taxonomic techniques, analysis of species; causal interpretation of animal diversity.
544. PHYSIOLOGICAL ECOLOGY (3) The physiological abilities of animals to tolerate and compensate for changes in the physical and chemical nature of the environment.
545. ECOSYSTEM DYNAMICS (3) Survey and discussion of recent literature on ecosystem structure and function. Prerequisite: Biol. 210.
546. ECOLOGY OF POPULATION AND COMMUNITIES (3) Ecological laws governing population growth and decline; reproductive and mortality rates; predation and composition as limiting factors. Fall term.
547. INVERTEBRATE BIOLOGY (3) Embryological development, metamorphosis, regeneration, and endocrinology of selected invertebrate groups (insects excluded). Invertebrate interactions and ecological impact.



550. **NEUROGENESIS (2)** Embryonic and evolutionary development of the nervous system. Determination, differentiation, orientation, and specificity of growing and regenerating nerve cells. Prerequisite: Biol. 440.

557. (Sci.Ed. 557) **WORKSHOPS IN THE BIOLOGICAL SCIENCES (3)** Projects designed for teachers of biology in the secondary schools. Summer term only.

571. (Phsio. 571) **ANIMAL PHYSIOLOGY (2)** Mammalian cardiovascular system; mammalian neurophysiology; excitable tissue, sensory systems, motor systems, and autonomic system. Prerequisite: Biol. 472.

572. (Phsio. 572) **ANIMAL PHYSIOLOGY (2)** Mechanisms involved in the activity and control of gastrointestinal function, respiration, and renal regulation of blood and body fluids. Prerequisite: Biol. 472.

573. (Phsio. 573) **ANIMAL PHYSIOLOGY (2)** Hypothalamic-hypophyseal relationships. Reproductive cycle regulation, endocrine control of fluid balance, body temperature, energy homeostasis, and metabolism of protein and minerals. Prerequisite: Biol. 472.

582. (Pty.Sc. 582, Psy. 582) **RESEARCH IN ANIMAL BEHAVIOR (2-6 per term)** Research in special areas of animal behavior involving field or laboratory work.

585. (M.C.B. 585) **BIOLOGICAL ULTRASTRUCTURE (4)** The application of electron microscopy to the study of cell biology. Prerequisite: Biol. 437 or 465 or Micrb. 401.

## **BIOPHYSICS (BPHYS)**

**(See MOLECULAR AND CELL BIOLOGY (M C B))**

## **BOTANY (BOT)**

E. S. LINDSTROM, *Head of the Department of Biology*  
208 Erwin W. Mueller Building  
814-865-4562

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Fergus, Grun, Hamilton, Hillson, Keener, Pursell, Schein, Spackman, Therrien, Traverse, and Wright.

*Graduate Faculty:* Associate Members Burriss and Stephenson.

Botanical programs are offered in plant anatomy, bryology, cytology, ecology, genetics, morphology, mycology, paleobotany, palynology, physiology, and taxonomy. A student having a degree in science or in one of the biological sciences is eligible for admission. Entering graduate students should have had basic courses in chemistry, mathematics, and physics. The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of one foreign language.

Admission is restricted to students who have the baccalaureate degree in a biological science and who present a cumulative undergraduate average of at least 3.00. Each applicant must provide scores from the Graduate Record Examination, a personal statement of interests and objectives, and letters from two persons verifying the applicant's academic competence.

See also Genetics and Physiology.

**NOTE:** *For courses in Botany and related subjects see Biology.*

## BUSINESS ADMINISTRATION (B A)

MICHAEL P. HOTTENSTEIN, *Director of the M.B.A. Program*

GEORGE C. PHILIPPATOS, *Director of the M.S. and Ph.D. Programs*

101 Business Administration Building  
814-863-0474

*Degrees Conferred:* Ph.D., M.S., M.B.A.

*Graduate Faculty:* Senior Members Aggarwal, Bear, Beik, Bennett, Bither, Bradley, Carroll, Coyle, Curley, Daniels, Dirmsmith, Durkin, Ezzell, Ferrara, Greenlaw, Hammond, Hayya, Heitmann, Henszey, Hottenstein, Jablonsky, Kelley, Kleindorfer, Kochenberger, Koot, Malcom, Olson, Pashek, Philippatos, Philips, Radebaugh, Reutzels, Snow, Stenger, Teichman, Tretter, Twark, Tyworth, Watson, Williams, R. Wilson, Wood, and D. Wilson.

*Graduate Faculty:* Associate Members Antil, Bluedorn, Cavinato, Chatterjee, Cochran, Davis, Koehler, Lusht, Luzi, Marlow, McCormack, Melander, Miller, Millman, Myers, Nelson, Phalan, Pitts, Rao, Reeder, Rethans, Reutzel, Snow, Stenger, Teichman, Tretter, Twark, Tyworth, Watson, Williams, R. Wilson, Wood, and Woolridge.

The Master of Business Administration is a professional degree program in business administration designed to prepare individuals for managerial positions in business, as well as government and other nonprofit institutions. Individuals of all undergraduate disciplines, both business and nonbusiness, are encouraged to apply. This program consists of two distinct portions: (1) 3 credits each in undergraduate accounting, statistics, and economics (not exclusively macroeconomics). These prerequisite courses may be taken as part of an undergraduate curriculum or at the University prior to starting graduate-level studies; (2) 48 credits of graduate courses and a professional paper.

Graduate-level work on the M.B.A. degree may be started fall term only. The time required to complete the graduate program, based on full-time study, is fifteen months. The student body is divided into diverse sections of approximately forty students, with each section proceeding through the same core classes. Emphasis is placed on student interaction and shared learning both inside and outside the classroom.

The M.S. and Ph.D. programs with a major in business administration are designed for those interested primarily in research and teaching. The communication and foreign language requirement for the Ph.D. degree may be satisfied by a reading knowledge of two foreign languages or a reading, listening, and speaking knowledge of one language. The candidate may substitute quantitative analysis and/or behavioral science for the required reading knowledge in one or two languages. A student has an option of a thesis or a paper for the M.S. degree.

For admission to the M.S. program, approximately 33 acceptable undergraduate credits in business administration, economics, and mathematics are required. An applicant may be admitted without foundation courses, but they must be made up without degree credit. Applicants are evaluated for admission on the basis of academic potential and other factors giving evidence of high probability of completing the program. Data useful for evaluating academic potential include the applicant's professional and academic accomplishments, the Graduate Management Admission Test (GMAT) scores, and recommendations. The best-qualified applicants will be accepted up to the number of spaces that are available for new students.

The College of Business Administration, in cooperation with the Department of French, offers concurrent master's degree programs in French studies and in business administration to provide training in both business and French studies for students who plan a career in international business. For details of the programs, see the description of the graduate programs in French, subsequent in this bulletin.

Applicants to any of the graduate programs in business administration are required to take the Graduate Management Admission Test (GMAT) which is administered by the Educational Testing Service four times a year. For dates, locations, and any other information on the test, write for the *Bulletin of Information*, Graduate Management Admission Test, Educational Testing Service, Princeton, NJ 08540.

This graduate program is accredited by the American Association of Collegiate Schools of Business.

Students in this program may elect the dual-title degree program option in operations research for the Ph.D. and M.S. degrees (see p. 249).



**ACCOUNTING (ACCTG)**

- 401. ADVANCED ACCOUNTING (3)
- 403. AUDITING (3)
- 404. MANAGERIAL ACCOUNTING (3)
- 406. ADVANCED FEDERAL TAXATION (3)
- 409. ACCOUNTING INFORMATION SYSTEMS (3)
- 413. AUDITING INTERNSHIP (3)
- 414. MANAGERIAL ACCOUNTING INTERNSHIP (3)
- 421. INTERNATIONAL ACCOUNTING (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

501. RESEARCH METHODS IN ACCOUNTING (3) An introduction to the methods and techniques of contemporary research in accounting. Prerequisites: Acctg. 504, 507, and a course in statistical inference.

503. SEMINAR IN AUDITING (3) The attest function of independent public accountants, verification of financial statements; problems of evidence, independence, ethics, professional responsibilities. Prerequisite: Acctg. 403.

504. SEMINAR IN MANAGERIAL ACCOUNTING (3-6) Accounting and the managerial processes of planning, control, and decision making.

507. SEMINAR IN FINANCIAL ACCOUNTING (3) Theoretical basis of financial accounting.

508. CONTEMPORARY ISSUES IN ACCOUNTING (3) Selected problems of current interest to the accounting profession.

511. FINANCIAL AND MANAGERIAL ACCOUNTING (3) Fundamental financial and managerial accounting concepts and issues from the viewpoint of the report user.

512. FINANCIAL ACCOUNTING THEORY AND REPORTING PROBLEMS (3) Measurement and reporting of financial information for external purposes, with particular attention to current problems in asset and income measurement. Prerequisite: Acctg. 511.

514. SEMINAR IN FEDERAL TAXATION (3) The federal tax structure, including legal, economic, and government implications; focusing on business decisions, research methodology, and tax planning.

515. DEVELOPMENT OF ACCOUNTING THOUGHT (3) Development of accounting thought from ancient civilizations to the present.

516. SEMINAR IN NOT-FOR-PROFIT ACCOUNTING (3) Measurement and structuring of financial information for managerial planning and control and external reporting.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2)

**BUSINESS ADMINISTRATION (B A)**

- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
- 499. FOREIGN STUDY — BUSINESS ADMINISTRATION (2-6)

503. SEMINAR IN PUBLIC UTILITIES (3)

517. COMMUNICATION SKILLS FOR MANAGEMENT (1 per term, maximum of 3) Development of communication skills required for management; audience awareness, style, individual and group presentations. Prerequisite: admission to the Master of Business Administration Program.

537. (Cmp.Sc. 537) **MANAGEMENT INFORMATION SYSTEMS DESIGN (3)** Cost, value, and technical considerations in analysis and design of information systems whose purposes are to aid decision making in organizations.
538. **INFORMATION SYSTEMS FOR PLANNING AND CONTROL (3)** Analysis of information requirements for planning, decision making, and performance measurement in organizations.
539. **SEMINAR IN MANAGEMENT INFORMATION SYSTEMS (3)** Special topics selected from contemporary issues in management information systems.
550. **BEHAVIORAL SCIENCE IN BUSINESS (3)** Application of behavioral science concepts and analytical methods to problems in business organizations. Analysis of administrative behavior and decision making.
555. **BUSINESS AND SOCIETY (3)** Evolution of the business organization and the changing framework of its operations, responsibilities, and social control.
560. **ENTERPRISE CONSULTING (3)** Student groups engaging in consulting relationships with enterprises through use of managerial techniques for identification, analysis, and solution of managerial problems. Prerequisites: Acctg. 511; B.A. 550, 555; Econ. 500; Q.B.A. 510 and 521.
574. **BUSINESS RESEARCH (1-3)** A project paper, comparable in quality and scope of work to a graduate thesis, on problems of a company. Prerequisite: 15 credits of 400- and 500-level courses in business administration.
577. **ADMINISTRATIVE INTEGRATION (3)** An analysis of coordination of the functional areas of business in relation to overall company objectives. Prerequisite: 15 credits of 400- and 500-level courses in business administration.
578. **ENTREPRENEURSHIP (3)** Study of the development or acquisition of a business appropriate to the objectives and resources of the individual entrepreneur.
590. **COLLOQUIUM (1-3)**
596. **INDIVIDUAL STUDIES (1-6)**
597. **SPECIAL TOPICS (1-6)**

### **BUSINESS LAW (B LAW)**

400. **REAL ESTATE LAW (3)**
410. **CRIMINAL LAW AND PROCEDURES IN THE BUSINESS COMMUNITY (3)**
496. **INDEPENDENT STUDIES (1-12)**
497. **SPECIAL TOPICS (1-6)**

### **BUSINESS LOGISTICS (B LOG)**

412. **TRANSPORT PLANNING ANALYSIS (3)**
420. **URBAN TRANSPORTATION (3)**
430. **TRANSPORT PROBLEMS (3)**
440. **LOGISTICS SYSTEMS ANALYSIS (3)**
496. **INDEPENDENT STUDIES (1-12)**
497. **SPECIAL TOPICS (1-6)**
538. **LOGISTICS SYSTEMS MANAGEMENT (3)** Control of the movement of goods; coordination of supply and demand in creation and maximization of time and place utility.
540. **TRANSPORT POLICY (3)** Role of transport in the economy. Transport systems elements, development, cost and pricing characteristics. Public control and public policies.
541. **SOCIOECONOMIC ANALYSIS IN TRANSPORTATION (3)** Role of transport in social and economic activity. Planning and coordination of transport systems. Designed for the traffic engineering program.
565. **SEMINAR IN BUSINESS LOGISTICS (3-6)**



- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)

## **FINANCE (FIN)**

- 405. CAPITAL BUDGETING (3)
- 406. SECURITY ANALYSIS AND PORTFOLIO MANAGEMENT (3)
- 408. FINANCIAL MARKETS (3)
- 410. SPECULATIVE MARKETS (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
- 504. PROBLEMS IN FINANCE (3-6) Planned individual projects involving library, laboratory, or field work.
- 505. (I.B. 505) MULTINATIONAL MANAGERIAL FINANCE (3) Analysis of the international aspects of managerial finance. Emphasis on the environmental and institutional factors influencing capital acquisition and allocation. Prerequisite: Fin. 531.
- 506. PORTFOLIO THEORY AND POLICY (3) Rigorous examination and analysis of asset-holder behavior under conditions of risk and uncertainty.
- 508. ANALYSIS OF FINANCIAL MARKETS (3) Analysis of factors affecting price determination in financial markets.
- 510. CONTEMPORARY ISSUES IN FINANCIAL INSTITUTIONS (3) Critical investigation of problems of current interest in the market structure and internal operations of financial institutions.
- 531. FINANCIAL MANAGEMENT (3) An intensive examination of techniques available to aid the financial manager in decision making.
- 532. FINANCIAL DECISION PROCESSES (3) Financial decision making under uncertainty; positive and normative models and current issues in financial management.
- 541. SECURITY ANALYSIS (3) Discussion and application of analytical techniques in security valuation, including use of computers.
- 561. SEMINAR IN FINANCE (3-6) Comparative analysis of research in the theories of finance; relationships to business management practices.
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)

## **INSURANCE (INS)**

- 400. ESTATE PLANNING (3)
- 401. FUNDAMENTALS OF PRIVATE PENSIONS (3)
- 410. COMPOUND INTEREST AND ANNUITIES — CERTAIN (3)
- 411. LIFE CONTINGENCIES I (3)
- 412. LIFE CONTINGENCIES II (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
- 500. INSURANCE THEORY AND PRACTICE (3) Insurance as an institution, a technique, a legal contract; its environment as a regulated industry.
- 504. PROBLEMS IN INSURANCE (3) Planned individual projects involving library, laboratory, or field work.

510. RISK MANAGEMENT (3) Analysis of managerial problems and responsibilities of risk analysis, removal or reduction, and allocation of corporate resources to provide indemnity.

596. INDIVIDUAL STUDIES (1-6)

### **INTERNATIONAL BUSINESS (I B)**

496. INDEPENDENT STUDIES (1-12)

497. SPECIAL TOPICS (1-6)

501. THE INTERNATIONAL ENVIRONMENT (3) Conceptual approach analyzing and predicting influences of social, political, and economic norms and values upon diverse societies' managerial decision making.

502. INTERNATIONAL BUSINESS MACRO THEORY AND POLICY I (3) International economic trade and monetary tools are applied to current national policy issues to determine effects on international business operations. Prerequisite: Econ. 333.

503. INTERNATIONAL BUSINESS MICRO THEORY AND POLICY I (3) Analysis of the internal operations of multinational firms; design of optimal strategies of operation under varying environmental conditions.

504. SEMINAR IN INTERNATIONAL BUSINESS (3-6) Seminar in techniques applied to selected topics; market structures; capital budgeting, investment; comparisons of foreign norms and values; multinational organization characteristics.

505. (Fin. 505) MULTINATIONAL MANAGERIAL FINANCE (3) Analysis of the international aspects of managerial finance. Emphasis on the environmental and institutional factors influencing capital acquisition and allocation. Prerequisite: Fin. 531.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

### **MANAGEMENT (MGMT)**

410. OPERATIONS PLANNING AND CONTROL (3)

420. MANAGEMENT OF PERSONNEL SYSTEMS (3)

422. ADVANCED ORGANIZATION THEORY (3)

430. ADMINISTRATIVE MANAGEMENT (3)

432. SIMULATION OF MANAGEMENT SYSTEMS (3)

496. INDEPENDENT STUDIES (1-12)

497. SPECIAL TOPICS (1-6)

510. OPERATIONS MANAGEMENT (3) Integration and application of decision making to operational and policy problems within the business firm.

515. DESIGN OF OPERATION OUTPUT SYSTEMS (3) Examination of research-based findings in operations management with a focus on the design and reliability of production systems.

516. OPERATIONS PLANNING AND CONTROL (3) Examination of research-based findings in operations management. The focus is on the operation and control of production systems.

517. MANAGEMENT OF SOCIO-TECHNICAL SYSTEMS (3) Surveys the economic, psychological, and sociological issues of work quality in terms of managerial implications and change strategies.

518. MANAGEMENT OF INVENTORY SYSTEMS (3) Analysis of business organizations as integrated inventory systems. Inventory theory and model building as tools for management decision making. Prerequisite: Q.B.A. 561 or Mgmt. 510 or I.E. 509.

520. COMPLEX ORGANIZATIONS: STRUCTURE AND DESIGN (3) Analysis of theory, research, and practice in the design of complex organizations. Relationships between organizational environments and structures are emphasized.



521. **ORGANIZATIONAL POWER AND CONTROL (3)** Theoretical and research emphasis on the bases and consequences of power and control in complex organizations.
523. **ORGANIZATIONAL CHANGE: THEORY AND PRACTICE (3)** Analysis of research, theory, and practice in dynamics of organizational change. Research literature reviewed for evaluation of concepts and methods.
524. **INTERPERSONAL RELATIONS IN ORGANIZATIONS (3)** Development of skills and sensitivity for dealing with interpersonal relationships in complex organizations. Prerequisite: B.A. 550.
531. **MANAGEMENT INFORMATION SYSTEMS (3)** Information system theories and methods applied to administrative structures and management decisions in organizations.
540. **PERSONNEL MANAGEMENT (3)** Theory and practice of personnel management and analysis of personnel problems of relevance to all types of managers.
570. **SEMINAR IN MANAGEMENT (3-6)** Comparative analysis of research in the theories of the administrative sciences; relationships to business management practices.
575. **FUTURE STUDIES AND MANAGERIAL PLANNING (3)** Theory and research on the "future" dimensions of decision making and planning, particularly under conditions of rapid change.
576. **PLANNING MODELS AND TECHNIQUES (3)** Survey of models, concepts, and techniques appropriate to managerial long-range planning in complex organizations.
590. **COLLOQUIUM (1-3)**
596. **INDIVIDUAL STUDIES (1-6)**
597. **SPECIAL TOPICS (1-6)**

## **MARKETING (MKTG)**

422. **SEMINAR: MARKETING COMMUNICATION (3)**
424. **MARKETING RESEARCH PROJECTS (3)**
430. **CONSUMER BEHAVIOR (3)**
435. **MARKETING AND PUBLIC POLICY (3)**
496. **INDEPENDENT STUDIES (1-12)**
497. **SPECIAL TOPICS (1-6)**
500. **MARKETING MANAGEMENT (3)** Analysis of management's marketing problems including market analyses, pricing, channel of distribution, promotion, competition, product strategies, and marketing research.
510. **PLANNING MARKET STRATEGY AND PROGRAMS (3)** Development of marketing strategy for the firm and design of integrated product-service, promotion, and distribution programs utilizing systems analysis.
520. **QUANTITATIVE ANALYSIS FOR MARKETING DECISIONS (3)** Sales forecasting, new product proposals, media selection, and market testing analyzed using statistical and decision theory and other mathematical techniques.
530. **CONSUMER AND MARKET BEHAVIOR (3)** Buying behavior: concepts from the behavioral sciences, including utility, culture, life cycle, personality, attitudes, and learning.
544. **MARKETING THEORY (3)** The development of marketing concepts; behavioral and other marketing theories; public policy and the role of marketing in societies.
596. **INDIVIDUAL STUDIES (1-6)**
597. **SPECIAL TOPICS (1-6)**

## QUANTITATIVE BUSINESS ANALYSIS (Q B A)

- 404. SAMPLING IN BUSINESS OPERATIONS AND RESEARCH (3)
- 451. LINEAR PROGRAMMING (3)
- 452. NONLINEAR PROGRAMMING (3)
- 461. PROBABILISTIC MODELS IN BUSINESS (3)
- 490. ADVANCED BUSINESS STATISTICS (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

\*398G. ACCELERATED BUSINESS STATISTICS (3) Basic characteristics of univariate and bivariate distributions, probability theory, introduction to estimation, tests of hypotheses, and time series analysis. Open to graduate students only.

500. SEMINAR IN BUSINESS STATISTICS (3-6)

501. ADVANCED BUSINESS STATISTICS (3)

510. STATISTICAL ANALYSIS FOR MANAGERIAL DECISION MAKING (3) Use of statistical methods for managerial decision making with emphasis on problem formulation, data analysis and interpretation, and business applications. Prerequisites: 3 credits each in undergraduate accounting, economics, and statistics.

521. QUANTITATIVE ANALYSIS FOR BUSINESS DECISIONS (3) Construction and use of quantitative methods in business decision making. Prerequisite: common requirements of M.B.A. program.

527. ANALYSIS FOR DECISION MAKING UNDER UNCERTAINTY (3) Topics in decision making under uncertainty including decision theory, Bayesian statistics, payoff function including utility theory and multi-attribute measures.

532. MANAGEMENT SYSTEMS SIMULATION (3) Application of computer simulation to the analysis and design of management decision systems. Design of simulation experiments in business research. Prerequisite: 3 credits of computer programming.

540. MATHEMATICAL PROGRAMMING (3) Nonlinear programming and geometric programming with emphasis on both theory and applications. Prerequisite: Q.B.A. 452.

550. SEMINAR IN MATHEMATICAL PROGRAMMING (3-6) Intensive treatment of theory and computational algorithms of mathematical programming; emphasis on operational application to complex management and business problems. Prerequisite: I.E. 510.

561. STOCHASTIC MODELS FOR MANAGEMENT DECISIONS (3) Introduction to stochastic processes in business organizations. Application of stochastic models to the conceptualization, analysis, and solution of management problems. Prerequisite: Math. (Stat.) 427.

570. MANAGEMENT SCIENCE: IMPLEMENTATION AND CONTROL (3) Development and application of management science models. Model formulation and specification, sensitivity analysis, problems encountered in implementation and control.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

## REAL ESTATE (R EST)

- 400. URBAN LAND UTILIZATION (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

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\*No graduate credit is given for this course.



## CERAMIC SCIENCE (CERSC)

RICHARD E. TRESSLER, *In Charge of Graduate Programs in Ceramic Science*  
201 Steidle Building  
814-865-7961

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Bradt, McKinstry, Newnham, Rindone, Spear, Stubican, and Tressler.

*Graduate Faculty:* Associate Members Messing and Pantano.

This program is one of the options in which a graduate student in the Department of Materials Science and Engineering can receive an advanced degree. In view of the wide field covered by ceramic science, the graduate courses may be selected with special emphasis in physical ceramics, chemical ceramics, or glass science.

The communication and foreign language requirement may be satisfied by (1) examinations in two languages, or (2) examination in one foreign language *and* either 6 credits of computer science or 6 credits of statistics, or 3 credits of computer science and 3 credits of statistics.

Special facilities exist for research in the areas of electroceramics, rheology, phase equilibria, solid state synthesis, mechanical properties, ferrite and ferroelectric studies, glass science, surface characterization and properties, high-temperature reaction kinetics, and corrosion studies. Suitable preparation for graduate study in this program may be found in one of the material sciences such as ceramics or metallurgy, in engineering fields such as chemical or mechanical engineering, in the basic physical sciences, or in the earth sciences.

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

## CERAMIC SCIENCE AND ENGINEERING (CERSE)

- 400. NONMETALLIC CRYSTAL CHEMISTRY (2-3) *Newnham*
- 402. PRINCIPLES OF CERAMIC ENGINEERING (3) *Messing*
- 404. CERAMIC SEMINAR (1)
- 406. RHEOLOGY AND FLUID PROPERTIES OF CERAMIC SYSTEMS (2) *Messing*
- 407. CERAMIC MATERIALS LABORATORY (2) *Messing*
- 408. THERMAL PROPERTIES OF CERAMIC MATERIALS (2) *Spear*
- 409. THERMAL PROPERTIES OF CERAMIC MATERIALS LABORATORY (2) *Spear*
- 410. PHASE RELATIONS IN CERAMIC SYSTEMS (3) *Spear*
- 411. PRINCIPLES OF CERAMIC PROCESSES (2) *Stubican*
- 414. MECHANICAL PROPERTIES OF CERAMICS (3) *Bradt*
- 415. PRINCIPLES OF GLASS TECHNOLOGY (3-4) *Pantano*
- 420. REFRACTORIES (2-3) *Stubican*
- 430. ELECTROCERAMICS (2) *Tressler*
- 431. ELECTROCERAMICS LABORATORY (1) *Tressler*
- 440. CARBON AND GRAPHITE (1) *Thrower*
- 441. CERAMIC NUCLEAR MATERIALS (1) *Spear*
- 496. INDEPENDENT STUDIES (1-12)

## CERAMIC SCIENCE (CERSC)

- 500. SEMINAR IN CERAMIC SCIENCE (1-2 per term) Current developments in ceramic science and related fields. Required of all graduate students in ceramic science.
- 501. SURFACE BEHAVIOR OF CERAMIC MATERIALS (2-4) Surface chemistry of ceramics. Rheology of ceramic powders, suspensions, and pastes. *Messing*

502. MECHANICAL PROPERTIES OF CERAMICS I (2) Theoretical considerations of the crystallographic and microstructural aspects of the elastic properties and fracture characteristics of ceramics. Prerequisite: Cersc. 414 or E.Mch. 415. *Bradt*
504. SOLID STATE REACTIONS IN CERAMIC SYSTEMS (2) Thermodynamic, kinetic, and structural study of reactions and of equilibrium in ceramic systems. Prerequisites: Chem. 451, 452. *Stubican*
505. PHASE TRANSITION IN SOLIDS (2) Phase transitions will be studied in detail with respect to the crystal structure, free energy, and physical properties. *McKinstry*
506. MECHANICAL PROPERTIES OF CERAMICS II (2) Theoretical considerations of dislocation processes, diffusion phenomena, and microstructural effects on the deformation and creep of ceramic materials. Prerequisite: Cersc. 502. *Bradt*
507. THERMAL PROPERTIES OF CERAMIC MATERIALS (2-3) Heat capacity, heat of fusion, thermal conductivity, and thermal expansion in relation to macroscopic measurements and basic atomic concepts applied to ceramic materials. *Tressler*
508. DIELECTRIC AND MAGNETIC PROPERTIES OF CERAMIC MATERIALS (2-3) Preparation and properties of ceramic semiconductors, dielectrics, and magnetic materials. *Newnham*
509. COMPOSITE MATERIALS (3) Manufacturing processes, atomic and molecular background, and topological relationships of macro- and microstructure to the physical properties of composites. *Tressler*
510. SEMINAR IN GLASS TECHNOLOGY (1-2 per term) Current developments in glass technology and related fields. *Pantano*
511. THE CONSTITUTION OF GLASS (2-3 per term) Historical and current concepts of the atomic structure of glass; relationship of structure to chemical and physical properties. *Pantano*
596. INDIVIDUAL STUDIES (1-6)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and the electron microprobe in ceramic science studies are listed under Materials Science — as are introductory courses in thermodynamics, kinetics, crystal chemistry, and crystal physics.*

## CHEMICAL ENGINEERING (CH E)

LEE C. EAGLETON, *Head of the Department*  
160 Merrell R. Fenske Laboratory  
814-865-2574

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Barton, Braun, Danner, Daubert, Duda, Eagleton, Engel, Helfferich, Kabel, Klaus, Tarbell, Ultman, Vannice, and Vrentas.

*Graduate Faculty:* Associate Members Graham and Peiffer.

Course offerings or research facilities are available in the following areas: phase equilibria, thermodynamics, kinetics, catalysis, transport phenomena, unit operations and processes, optimization, polymer physics, bioengineering, process dynamics, mathematical modeling, applied chemistry, surface and colloid chemistry, petroleum technology, rheology, and lubrication. A foreign language is not required for the Ph.D. degree.

To be admitted, a student should be a graduate of an accredited major in chemical engineering or the equivalent. Graduates of other accredited engineering or physical science majors may be admitted but will be required to make up certain undergraduate deficiencies without graduate credit. Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. Applicants attending foreign universities are required to submit Graduate Record Examination scores. The best-qualified applicants will be accepted up to the number of spaces that are available for new stu-



dents. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

### CHEMICAL ENGINEERING (CH E)

- 401. CHEMICAL PROCESS ENGINEERING (3)
  - 407. CHEMICAL ENGINEERING LABORATORY (3)
  - 408. CHEMICAL ENGINEERING LABORATORY II (2)
  - 413. MASS TRANSFER OPERATIONS (4)
  - 414. KINETICS AND INDUSTRIAL CHEMISTRY (4)
  - 415. MATHEMATICAL MODELING IN CHEMICAL ENGINEERING (3)
  - 416. TECHNIQUES OF PROCESS DESIGN (3)
  - 420. CRYOGENIC ENGINEERING (3)
  - 422. MODERN PETROLEUM TECHNOLOGY — PROCESSES AND PRODUCTS (3)
  - 430. NUCLEAR CHEMICAL ENGINEERING (3)
  - 431. ADVANCED INDUSTRIAL CHEMISTRY APPLICATIONS (3)
  - 440. CHEMICAL ENGINEERING MATERIALS (3)
  - 441. POLYMER PROCESSING (3)
  - 445. PROJECTS IN CHEMICAL ENGINEERING (1-6)
  - 446. INTRODUCTION TO TRANSPORT PHENOMENA (3)
  - 448. ADVANCED MASS TRANSFER OPERATIONS (3)
  - 450. PROCESS DYNAMICS (3)
  - 453. THERMODYNAMICS FOR CHEMICAL ENGINEERS (3)
  - 455. CHEMICAL REACTOR DESIGN (3)
  - 460. CHEMICAL ENGINEERING (4)
  - 464. DESIGN OF CHEMICAL PLANTS (2)
  - 465. DESIGN PROJECTS IN CHEMICAL ENGINEERING (1-6)
  - 497. SPECIAL TOPICS (1-6)
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- 507. SIMULATION AND MODELING (3) Synthesis of subsystem and system models emphasizing the generality of the principles for application to diverse physical and chemical processes.
  - 509. HEAT TRANSFER APPLICATIONS (3) Advanced treatment of steady-state and transient conduction, convection, and radiation, with emphasis on numerical methods and design techniques. Prerequisite: an undergraduate course in heat transfer. *Daubert*
  - 516. METHODS OF PROCESS DESIGN (3) Survey of mathematical techniques of chemical process design with emphasis on economic choice and optimal decision making. *Engel*
  - 524. CHEMICAL ENGINEERING, APPLICATION OF THERMODYNAMICS (3) Elements of thermochemistry and thermodynamics of greatest importance in chemical engineering.
  - 535. CHEMICAL REACTION ENGINEERING (3) Optimal design of batch and continuous chemical reactors and reactor batteries; effect of mixing on reactor operation.
  - 536. HETEROGENEOUS CATALYSIS (3) Thermodynamics and kinetics of adsorption and reactions on solid surfaces, heat and mass transfer effects, theory and correlations in catalysis. Prerequisites: Chem. 451, 452.
  - 545. TRANSPORT PHENOMENA I (3) Momentum, heat, and mass transfer, steady and unsteady state, laminar and turbulent flow, coupling, analogies, chemical engineering applications.
  - 546. TRANSPORT PHENOMENA II (3) Momentum, heat, and mass transfer, steady and unsteady state, laminar and turbulent flow, coupling, analogies, chemical engineering applications.
  - 548. MULTISTAGE MASS TRANSFER OPERATIONS (3) Rigorous solution of complex problems in distillation, extraction, and absorption including computer methods. Prerequisite: an undergraduate course in mass transfer. *Barton*
  - 596. INDIVIDUAL STUDIES (1-6)
  - 597. SPECIAL TOPICS (1-6)
  - 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

**CHEMISTRY (CHEM)**

JOSEPH A. DIXON, *Head of the Department*  
 152 Davey Laboratory  
 814-865-6553

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Allcock, Anderson, Benkovic, Bernheim, Deno, Dixon, Fritz, Geoffroy, Gold, Haas, Hamilton, Heicklen, Hisatsune, Horrocks, Jackman, Jordan, Jurs, Lampe, Lowe, Olofson, Richey, Rosenblatt, Shamma, Skell, Steele, Villafranca, Wartik, Weinreb, and Winograd.

*Graduate Faculty:* Associate Members DeShong, Garrison, Matthews, Minard, and Sen.

The Ph.D. program in chemistry provides students with a broad background in one of the areas of chemistry (analytical, biological, inorganic, organic, or physical) and intensive research experience culminating in the preparation of a formal thesis. The goal of the program is to prepare students for a variety of careers in academia, government, or industry. The general facilities are excellent, and the computer, cryogenic, and spectroscopy laboratories provide unusual research opportunities. Distinguished visiting scholars conduct informal discussions each Thursday at a departmental colloquium.

The department requires a knowledge of French, German, Japanese, or Russian as a condition for awarding either the M.S. or Ph.D. degree. Candidates who have taken and passed two undergraduate courses in French, German, Japanese, or Russian will be certified as having completed the communication and foreign language requirement. For the M.S. degree the student has the option of writing a thesis or a paper.

For admission, at least integral calculus plus one year's work in general physics, organic chemistry, physical chemistry, and either analytical or inorganic chemistry are normally required. Students who have appropriate course backgrounds and who present a 2.50 average in all undergraduate courses in chemistry, physics, and mathematics will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

Prior to scheduling their first term programs, new students will take placement examinations in the areas of analytical, inorganic, organic, and physical chemistry. The information obtained from these tests will assist both the student and the adviser in making up a program best suited to the student's needs. These examinations are normally given just prior to the regular registration period.

**CHEMISTRY (CHEM)**

- 400. CHEMICAL LITERATURE (1)
- 405. APPLIED NUCLEAR AND RADIOCHEMISTRY (3)
- 408. (Cmp.Sc. 408) COMPUTER APPLICATIONS IN CHEMISTRY (3)
- 410. INORGANIC CHEMISTRY (2)
- 411. ADVANCED INORGANIC CHEMISTRY (2)
- 426. CHEMICAL INSTRUMENTATION (3)
- 427. INSTRUMENTAL ANALYSIS (2)
- 428. INSTRUMENTAL ANALYSIS (2)
- 429. INSTRUMENTAL ANALYSIS (2)
- 431. ORGANIC AND INORGANIC PREPARATIONS (3)
- 439. STRUCTURAL ANALYSIS OF ORGANIC COMPOUNDS (3)
- 448. SURFACE CHEMISTRY (2)
- \*451-452. PHYSICAL CHEMISTRY (3 each)
- 453. THERMODYNAMICS OF CHEMICAL SYSTEMS (3)
- 454. INTRODUCTION TO QUANTUM CHEMISTRY (3)

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\*Graduate credit not allowed for students majoring in chemistry or chemical engineering.



455. PHYSICAL CHEMISTRY OF HIGH POLYMERS (3)
- \*457. EXPERIMENTAL PHYSICAL CHEMISTRY (1-2)
- \*458. EXPERIMENTAL PHYSICAL CHEMISTRY (1-2)
- †489. INTRODUCTION TO CHEMICAL RESEARCH (1-10 per term, maximum of 20)
500. SEMINAR IN CHEMISTRY (1 per term)
- 516-517. INORGANIC CHEMISTRY (3 each) Systematic treatment of inorganic chemistry in terms of modern concepts.
518. SPECIAL TOPICS IN INORGANIC CHEMISTRY (3 per term) Modern developments in specialized fields.
525. ANALYTICAL PROCESSES (3) Theoretical foundations and contemporary developments.
526. MODERN INSTRUMENTAL ANALYSIS (3)
527. SPECIAL TOPICS IN ANALYTICAL CHEMISTRY (2-12)
531. SPECIAL TOPICS IN ORGANIC CHEMISTRY (3-12) Prerequisite: Chem. 536.
534. CHEMICAL APPLICATIONS OF QUANTUM THEORY (3) A development of Molecular Orbital Theory up to the level of present-day usage in organic and inorganic chemistry.
- 535-536. ORGANIC REACTION MECHANISMS I AND II (3 each) Reaction mechanisms and their determination by kinetic and nonkinetic methods. Reactive intermediates. Prerequisite: Chem. 439.
537. SYNTHESIS IN ORGANIC CHEMISTRY (3) Theory and methods of directed syntheses, including stereospecific and stereoselective schemes; biologically inspired syntheses. Prerequisite: Chem. 536.
544. CHEMICAL THERMODYNAMICS (3) Development of thermodynamic theory with special reference to common physical changes and chemical reactions. Prerequisite: Chem. 452.
545. STATISTICAL THERMODYNAMICS (3) The calculation of thermodynamic properties from molecular and spectroscopic data. Prerequisites: Chem. 453 or 544, and Chem. 565.
560. TOPICS IN PHYSICAL CHEMISTRY (2-6)
563. CHEMICAL KINETICS (3) Theory and measurement of the rates of chemical reactions, molecular dynamics, and mechanisms of chemical reactions. Prerequisites: Chem. 453 or 544, and Chem. 565.
565. ATOMIC AND MOLECULAR STRUCTURE (3) Introduction to modern theoretical chemistry, spectroscopy, and structure of atoms and molecules.
566. QUANTUM CHEMISTRY (3) Theoretical calculations of electronic properties of atoms and molecules. Prerequisites: A.M. 432 and Chem. 565.
567. QUANTUM CHEMISTRY (3) A continuation of Chem. 566, including problems and theories of electron correlation. Prerequisite: Chem. 566.
571. POLYMER CHEMISTRY (3) The synthesis, reactions, and structure determination of high polymers.
589. STUDIES IN CHEMISTRY (1-9) Theoretical research, experimental research, or a critical survey of the literature in an area of chemistry.
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

\*Graduate credit not allowed for students majoring in chemistry or chemical engineering.

†Graduate credit not allowed for students majoring in chemistry.

## CIVIL ENGINEERING (C E)

ROBERT M. BARNOFF, *Head of the Department*  
212 Sackett Building  
814-865-8391

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Senior Members Aron, Barnoff, Cady, Gotolski, Larson, Long, McDonnell, Miller, Nesbitt, Reed, Regan, Untrauer, Unz, Wang, West, and Willenbrock.

*Graduate Faculty:* Associate Members Anderson, Davinroy, Deutsch, Gburek, Kibler, Kilaeski, Marks, McClure, Mazingo, and Thomas.

Students may specialize in structures, hydraulics, hydrology, transportation engineering, traffic engineering, materials, construction, soils, and environmental engineering, or combinations of these. Relevant courses are offered both by the Department of Civil Engineering and by other departments of the University.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by a reading knowledge of one foreign language (French, German, or Russian) and proficiency in English, according to the department's requirements. A thesis is required for the M.S. degree. An engineering report is required for the M.Eng. degree.

Candidates normally should be graduates from an accredited program in engineering. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. Applicants must submit Graduate Record Examination Aptitude test scores. Entering graduate students for whom English is not the first language are required to have a score of at least 550 on the TOEFL (Test of English as a Foreign Language) examination. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

Students in this program may elect the dual-title degree program option in operations research for the Ph.D. and M.S. degrees (see p. 249).

*See also Environmental Engineering.*

## CIVIL ENGINEERING (C E)

- 400. SEMINAR (1-3)
- 411. BOUNDARY SURVEYING (3)
- 412. PHOTOGRAMMETRY AND PHOTO INTERPRETATION (3)
- 421. TRANSPORTATION FACILITIES DESIGN (3)
- 423. TRANSPORTATION SYSTEMS OPERATIONS (3)
- 424. CIVIL ENGINEERING MATERIALS (3)
- 427. RAILWAY TRACK STRUCTURE AND TERMINAL SYSTEMS (3)
- 428. RAILWAY OPERATING SYSTEMS AND ANALYSIS (3)
- 431. CIVIL ENGINEERING CONSTRUCTION (3)
- 432. CONSTRUCTION PROJECT CONTROL (3)
- 446. ADVANCED SOIL MECHANICS I (3)
- 447. STRUCTURAL ANALYSIS BY MATRIX METHODS (3)
- 448. ADVANCED STRUCTURAL DESIGN (3)
- 449. DESIGN OF PRESTRESSED AND REINFORCED CONCRETE STRUCTURES (3)
- 451. ADVANCED HYDROLOGY (3)
- 462. OPEN CHANNEL HYDRAULICS (3)
- 465. RIVER AND WATERWAYS ENGINEERING (3)
- 471. ENVIRONMENTAL SANITATION (3)
- 472. WATER POLLUTION CONTROL PROCESSES (3)
- 473. WATER QUALITY MANAGEMENT (3)
- 474. MANAGEMENT OF WATER POLLUTION CONTROL PROCESSES (3)
- 475. WATER QUALITY CHEMISTRY (1)



- 476. SOLID WASTE MANAGEMENT (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

511. ENGINEERING SOIL CHARACTERISTICS (3) Applications of physico-chemical principles in soil engineering, soil composition, factors influencing engineering soil properties. Prerequisite: C.E. 244.

512. SOIL MECHANICS II (2-5) Evaluation of strength parameters and compressibility of soils; elastic analysis of stress and strain; techniques of forecasting foundation settlement; slope stability analysis. Prerequisite: C.E. 446.

513. ADVANCED FOUNDATION ENGINEERING (3) Practical applications of soil mechanics principles to geotechnical engineering problems; dewatering techniques; design of deep foundations and retaining structures. Prerequisite: C.E. 244.

518. LAND USE MODELS (3) The urban planning process; transportation models; economic, residential, industrial retail, and public sector submodels; integrated models; simulation models; evaluative models. Prerequisite: 3 credits of computer science.

520. PAVEMENT DESIGN (3) Fundamental principles; properties of pavement components; design tests; design of flexible pavements; design of rigid pavements; pavement evaluation and strengthening. Prerequisites: C.E. 224, 244.

521. TECHNIQUES OF TRANSPORTATION ANALYSIS (2-4) Transportation functions, travel patterns, basic analytical methods in the planning content. Prerequisite: 3 credits of computer science.

522. HIGHWAY OPERATIONS (2) Theory and application of traffic controls, including functional operations of traffic signals, systems, and networks; the design of highway lighting. Prerequisite: C.E. 423.

523. URBAN TRANSPORTATION PLANNING, TECHNOLOGY, POLICY, AND ADMINISTRATION (2-4) Characteristics of urban areas, the urban transportation planning process, present and future urban transportation systems, urban transportation policy and administration. Prerequisite: C.E. 221.

524. ADVANCED PROBLEMS IN CIVIL ENGINEERING MATERIALS (2-6) Study, in the literature and by laboratory investigation, of selected topics on field-controlled civil engineering materials. Prerequisite: C.E. 424.

525. AIRPORT PLANNING AND DESIGN (3) Aircraft characteristics; aeronautical demand; site selection; airport configuration; capacity analysis; design of landing and terminal areas. Prerequisite: C.E. 221.

531. LEGAL ASPECTS OF ENGINEERING AND CONSTRUCTION (3) Basic legal doctrines, contractual relationships between parties, analysis of construction contract clauses, contract performance, and professional practice problems. Prerequisite: C.E. 431.

532. POWER PLANT CONSTRUCTION (3) Fossil and nuclear power generation; analysis of power plant design and civil, mechanical, and electrical construction phases; quality assurance role. Prerequisite: C.E. 431.

539. APPROXIMATE METHODS OF STRUCTURAL ANALYSIS (3) Newmark's method, finite difference method, and finite element method applied to problems in structural and soil engineering. Prerequisite: C.E. 240.

540. STRUCTURAL ANALYSIS BY CLASSICAL METHODS (3) Analysis of continuous trusses and beams, frames, arches, grids, curved beams, suspension systems, and space frames. Prerequisite: C.E. 240.

541. STRUCTURAL ANALYSIS (3) Analysis of continuous beams and frames, grids, slabs, shells, and three-dimensional structural and soils problems by finite element methods. Prerequisite: C.E. 447.

544. REINFORCED CONCRETE STRUCTURES (3) Working stress, ultimate strength, and limit design; test behavior of beams, columns, and slabs. Prerequisite: C.E. 341.

545. DESIGN OF METAL STRUCTURES (3) Steel, aluminum members; flexible connections; composite, hybrid, prestressed beams; tension-field beams; buckling; plastic analysis, design; test data; timber design. Prerequisite: C.E. 342.
546. THIN CONCRETE STRUCTURES (3) Design of thin concrete structures including slabs, folded plates, and shells. Prerequisite: C.E. 341.
548. STRUCTURAL DESIGN FOR DYNAMIC LOADS (3) Dynamic behavior of structural systems of one and more degrees of freedom; earthquake, blast-resistant analysis, and design of structures. Prerequisites: E.Mch. 12, C.E. 240.
550. ENGINEERING CONSTRUCTION MANAGEMENT (3) Management fundamentals for construction contracting; organization, project planning, scheduling and control, bonding and insurance, labor legislation and regulation, cost and control. Prerequisite: C.E. 431.
551. HYDROLOGIC INVESTIGATIONS (2-8) Application of hydrologic principles and techniques to a specific project. Prerequisite: C.E. 451 or 452.
552. HYDROLOGIC PROCESSES AND CYBERNETICS (3) Application of cybernetic concepts in electronic computer simulation of the hydrologic process-components: infiltration, precipitation, evapotranspiration, and overland flow. Prerequisite: C.E. 351 or 452.
553. PLANNING MULTIPURPOSE HYDROLOGIC SYSTEMS (3) Study of multipurpose hydrologic schemes within a social, economic, and political framework. Prerequisites: C.E. 451 or 452; Econ. 14.
554. URBAN HYDROLOGY (3) Several hydrograph methods. Design storm and IUH application; airport drainage; flood plains; impact of urbanization upon groundwater and sediment. Prerequisite: C.E. 451 or 452.
560. DIMENSIONAL ANALYSIS AND THEORY OF MODELS (3) Principles of dimensional analysis and similitude with engineering applications primarily to problems in hydromechanics. Prerequisite: C.E. 261.
564. HYDRAULIC ENGINEERING DESIGN (3) Design and analysis of selected units of a typical hydraulic engineering project. Prerequisite: C.E. 362.
570. PHYSICAL CHEMICAL TREATMENT PROCESSES I (2) The theory of physical-chemical processes used in the treatment of potable water and municipal and industrial wastewaters. Prerequisite: C.E. 472.
571. PHYSICAL CHEMICAL TREATMENT PROCESSES II (3) The theory of physical-chemical processes used in the treatment of potable water and municipal and industrial wastewaters. Prerequisite: C.E. 472.
572. BIOLOGICAL TREATMENT PROCESSES (2) The theory of biological processes used in the treatment of municipal and industrial wastewaters. Prerequisite: C.E. 472.
574. LABORATORY ANALYSES IN WATER QUALITY CONTROL (3) Experiments illustrating current chemical and biochemical methods of water and waste treatment and analytical methods used in research and control. Prerequisite: Chem. 14.
575. INDUSTRIAL WASTE TREATMENT (2) Surveys and data analysis; use of unit processes to meet regulatory agency requirements; disposal of gaseous and solid residues. Prerequisite: C.E. 472.
577. TREATMENT PLANT DESIGN (1-6) Design of works for the treatment of water and wastewater for municipalities and industries. Prerequisites: C.E. 472 and 3 credits in hydraulics.
579. (Micrb. 529) AQUATIC MICROBIOLOGY (3) Ecology and physiology of microorganisms of inland waters, estuaries, and oceans; microbiology of wastewater treatment. Prerequisite: introductory microbiology.
580. STREAM AND ESTUARINE ANALYSIS (3) Quantitative assessment of advection, reaction, and dispersion processes in polluted waters; reaeration theory; eutrophic systems; analog simulation. Prerequisite: C.E. 472.
590. COLLOQUIUM (1-3)



- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## CLASSICS (CLASS)

ARCHIBALD ALLEN, *Head of the Department*  
 109 Carnegie Building  
 814-865-8851

*Degree Conferred:* M.A.

*Graduate Faculty:* Senior Members Carrubba and Donlan.

*Graduate Faculty:* Associate Member Allen.

The master's degree in classics is intended either as a terminal degree which (combined with the appropriate courses in educational theory and technique) equips students to teach at the elementary or secondary school level, or as preliminary to further graduate study at the doctoral level. The program allows specialization in either Latin or Greek but not to the exclusion of the other language. Although 18 undergraduate credits in some combination of Latin and Greek are the normal minimum requirements for admission, candidates can be admitted with deficiencies in the languages if these are compensated by training in ancient history, civilization, or archaeology. The required 2.50 grade-point average in junior-senior courses, normally considered a minimum for admission, will also be waived in special cases.

Of the 30 graduate credits required for the M.A., 6 may take the form of a supervised thesis. Candidates who choose not to submit a thesis must schedule 6 additional credits of course work. Besides the courses listed below, offered by the Department of Classics, candidates may schedule up to 9 credits in appropriate related subjects — such as ancient history, ancient philosophy, art history, or linguistics — offered by the respective departments. The comprehensive examination comprises a translation paper in either Latin or Greek, an essay exam in three areas of the student's choice in Greek and Latin literature, and a reading examination in a modern language (normally French or German).

## GREEK (GREEK)

- 401. INTRODUCTORY READINGS IN GREEK LITERATURE (3)
- 420. THE GREEK HISTORIANS (3)
- 421. GREEK TRAGEDY (3)
- 422. GREEK COMEDY (3)
- 431. PLATO (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
- 507. PROBLEMS IN GREEK ARCHAEOLOGY (3-9)
- 509. GREEK SEMINAR (3-9)
- 517. GREEK RESEARCH (1-6) Prosecution of an assigned problem under the guidance of a member of the department.

## LATIN (LATIN)

- 401. INTRODUCTORY READING IN LATIN LITERATURE (3)
- 402. LATIN LITERATURE OF THE REPUBLIC (3-9)
- 403. LATIN LITERATURE OF THE AUGUSTAN AGE (3-9)
- 404. LATIN LITERATURE OF THE EMPIRE (3-9)
- 437. LATIN PROSE COMPOSITION (3-6)

- 461. (Ling. 461) HISTORY OF THE LATIN LANGUAGE (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

500. LATIN LITERATURE (3-9) Readings in the major forms of Latin literature; content varies; course may be repeated.

510. LATIN SEMINAR (3-6)

518. LATIN RESEARCH (1-6) Prosecution of an assigned problem under the guidance of a member of the department.

#### **\*CLASSICS (CLASS)**

- 405. STUDIES IN GREEK MYTHOLOGY (3)
- 408. GREEK RELIGION AND MODERN MAN (3)
- 410. CLASSICAL EPIC (3)
- 411. CLASSICAL DRAMA (3)
- 496. INDEPENDENT STUDIES (1-12)

500. INTRODUCTION TO CLASSICAL SCHOLARSHIP (1-6) Lectures on the methods and materials of classical scholarship. To be scheduled by graduate students in their first term and as necessary thereafter.

504. TOPOGRAPHY OF ANCIENT ROME (3) Lectures and readings on physical development of the ancient city of Rome from earliest habitation to time of later empire.

597. SPECIAL TOPICS (1-6)

## **COMMUNICATION DISORDERS (CMDIS)**

FREDERICK F. WEINER, *In Charge of Graduate Programs in Communication Disorders*  
110 Moore Building  
814-865-5414

*Degrees Conferred:* Ph.D., M.S., M.Ed.

*Graduate Faculty:* Senior Members Frank, Frick, Gilbert, Michael, Siegenthaler, and Weiner.

*Graduate Faculty:* Associate Members Klevans, Prinz, and Stoker.

Students may specialize in speech pathology, audiology, or education of the hearing impaired. The programs include the requirement of a number of field trips to diagnostic and treatment facilities and may include a period of internship at an off-campus location to be assigned by the staff. Students should expect to have moderate expenses related to these trips.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by options selected from designated areas including, but not restricted to, foreign languages. The nonthesis option is available for the M.S. degree.

Approximately 38 credits are required for admission, distributed among speech pathology, audiology, education of the hearing impaired, speech science, education, and psychology, and including a course in statistics. Students entering without an undergraduate program in the field may be required to take additional make-up work.

Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

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\*The readings are in English; knowledge of Greek and Latin is not required.



Although occasionally admitted for the summer term, new master's students in the speech pathology option generally are admitted to the option only in the fall term.

## COMMUNICATION DISORDERS (CMDIS)

430. INTRODUCTION TO AUDIOLOGY (3)
433. VISUAL SPEECH RECEPTION AND AUDITORY TRAINING (3)
439. PRACTICUM IN AUDITORY TRAINING AND SPEECH READING (1-5)
440. (Spl.Ed. 440) SURVEY OF SPEECH AND HEARING DISORDERS (3)
442. SPEECH PATHOLOGY I (3)
444. SPEECH PATHOLOGY II (3)
445. PROFESSIONAL PROGRAMS AND RELATIONSHIPS (3)
449. PRACTICUM IN SPEECH THERAPY (1-6)
459. PRINCIPLES OF CLINICAL MANAGEMENT IN S.P.A. (2)
460. COMMUNICATION SKILLS FOR HEARING IMPAIRED I (2)
461. COMMUNICATION SKILLS FOR HEARING IMPAIRED II (3)
462. CLINICAL BASES OF LANGUAGE DISORDERS (2)
463. TEACHING LANGUAGE TO THE HEARING IMPAIRED (3)
- 464-465. TEACHING SCHOOL SUBJECTS TO THE DEAF (2 each)
469. STUDENT TEACHING WITH THE DEAF (3-12)
496. INDEPENDENT STUDIES (1-12)
497. SPECIAL TOPICS (1-6)
515. APPLICATION OF PHYSIOLOGICAL AND ACOUSTICAL CONCEPTS OF SPEECH PATHOLOGY AND AUDIOLOGY (4) Application of practical and theoretical concepts in neurology, physiology, and acoustics to communication disorders with implications for clinical therapy. Prerequisites: 6 credits in speech science and 6 credits in speech pathology and audiology.
517. (Ling. 517) APPLICATIONS OF LINGUISTICS TO COMMUNICATION DISORDERS (1) Application of linguistic theory to the understanding of communication disorders, with clinical implications for speech and language therapy. Prerequisite: 12 credits in communication disorders, psychology, linguistics, or phonetics.
522. (Sp.Com. 522) SPEECH PERCEPTION (3) Transformation of linguistic units into acoustic speech signals, theories of speech perception, and auditory processing of the speech signal. Prerequisites: Sp.Com. 410, 431, 520.
531. HEARING AIDS (3) Hearing aid circuitry, electroacoustic characteristic measurement, and evaluation techniques and procedures for infants, children, and adults. Prerequisites: Acs. 401, Cm.Dis. 535.
532. ACOUSTICAL INSTRUMENTS FOR HEARING (3) Acoustical instrumentation used for research in hearing, programs of hearing conservation, and noise control, including clinical and industrial applications. Prerequisite: 6 credits in acoustics, audiology, experimental psychology, or speech science at 400 level.
533. SPEECH AUDIOMETRY (2) Techniques, interpretation, and differential diagnosis of hearing ability employing speech and speech-like materials in children and adults. Prerequisites: Acs. 401, Cm.Dis. 430, 433; 6 additional credits in communication disorders.
534. NOISE AND HEARING (3) Noise-induced hearing problems; interference with communication; annoyance and community problems caused by acoustic energy; regulations and standards. Prerequisite: 6 credits at the 400 level in acoustics, audiology, experimental psychology, or speech science.
535. PURE TONE AUDIOMETRY (3) Techniques, interpretation, and differential diagnosis of hearing ability by pure tone and related audiometric techniques. Prerequisites: Cm.Dis. 430, 433, Acs. 401; 6 credits in speech pathology and audiology.
538. PRACTICUM IN AUDIOLOGIC EVALUATION AND SELECTION OF HEARING AIDS (1-5) Prerequisite: Cm.Dis. 531.
539. ADVANCED PRACTICUM IN EDUCATION OF THE DEAF (1-6) Theoretical and clinical rationale of

working with hearing impaired, professional role and relationships, therapy procedures, evaluation of process and outcomes. Prerequisite: Cm.Dis. 439.

540. ARTICULATION DISABILITIES (3) Speech-sound production disorders in children and adults; methods of examination, diagnosis, and treatment. Prerequisites: Cm.Dis. 442, 449.

541. THE VOICE AND ITS DISORDERS (3) Physical, physiological, and psychological bases of voice production; causes, nature, and symptoms of its disorders; current clinical methods in voice improvement. Prerequisites: Cm.Dis. 444, 449.

542. STUTTERING (3) Modern theories of causes of disorders of rhythm; methods of examination, diagnosis, and treatment. Prerequisites: Cm.Dis. 442, 449.

543. DIAGNOSTIC PROCEDURES IN CLINICAL SPEECH (3) Clinical instrumentation; case history taking; examination procedures and materials used in diagnosing speech disabilities; interpretation of findings; report preparation. Prerequisite: Cm.Dis. 444.

544. CLEFT PALATE (3) Anatomy, physiology, embryology, and growth of the palate and contiguous structures; etiology, diagnosis, habilitation of cleft palate problems. Prerequisite: Cm.Dis. 444.

545. NEUROMOTOR DISORDERS OF SPEECH (3) Etiology and symptomatology of dysarthric and apraxic speech: diagnosis, treatment, and the team rehabilitative program approach to these disorders. Prerequisite: Cm.Dis. 444 or 515 or Sp.Com. 431.

546. LANGUAGE DISORDERS IN ADULTS (3) Nature, etiology, diagnosis, and management of language disorders in adults. Prerequisite: 9 credits in speech pathology and audiology or related fields such as psychology, linguistics, or human development.

547. (Spl.Ed. 547) LANGUAGE DISORDERS IN CHILDREN (2) Nature, etiology, diagnosis, and management of language disorders in children. Prerequisite: 9 credits in speech pathology and audiology or related fields such as psychology, linguistics, or human development.

548. PRACTICUM IN SPEECH DIAGNOSIS (1-3) Supervised practice in interviewing, counseling, speech evaluation, and synthesis of psychological, medical, and audiological data in speech diagnosis; report writing. Prerequisites: Cm.Dis. 444, 449.

549. ADVANCED PRACTICUM IN SPEECH THERAPY (1-6) Theoretical and clinical rationale of therapy; professional role and relationships; therapy procedures, individual and group; evaluation of process and outcomes. Prerequisites: Cm.Dis. 442, 449.

550. SEMINAR IN SPEECH PATHOLOGY (1-6) Advanced study of special problems and new developments in speech pathology. Prerequisites: Cm.Dis. 442, 444.

560. RECENT DEVELOPMENTS IN EDUCATION OF THE DEAF (2-6) In-depth seminar-style study of communication disorders associated with deafness, and advanced and experimental attempts at remediation. Prerequisites: 8 credits in education of the deaf or audiology; Cm.Dis. 430, 433; 3 credits in child development or learning theory.

566. EDUCATION AND GUIDANCE OF THE HEARING IMPAIRED (3) Effects of hearing impairment on developmental, educational, social, and vocational adjustment; assisting the hearing impaired toward improved life adjustment. Prerequisites: Cm.Dis. 430, 433.

567. AUDIOLOGY FOR HEARING AND SPEECH CLINICIANS (3) Etiology, measurement, and differential diagnosis of hearing loss; overview of aural rehabilitation, including hearing aids and auditory training systems. Prerequisites: Cm.Dis. 430, 433; 6 credits in speech pathology and audiology.

571. THEORIES OF HEARING (2) Development of theories of hearing, current trends in psychoacoustic research, and recent trends in hearing theories. Prerequisite: Acs. 401 or 402.

574. PEDIATRIC AUDIOLOGY (2) Etiology, differential diagnosis, habilitation, and rehabilitation of hearing loss associated with infants, preschool, and school-age children. Prerequisite: Cm.Dis. 535 or 567.

575. SPECIAL AUDIOLOGICAL TESTS (3) Theory, administration, and interpretation of special audiological tests to determine the site of lesion of a hearing loss. Prerequisites: Cm.Dis. 533, 535.

596. INDIVIDUAL STUDIES (1-6)



## COMMUNITY SYSTEMS PLANNING AND DEVELOPMENT (CSP D)

R. RICHARD RITTI, *Chairman of Graduate Programs in Community Systems Planning and Development*

S-210 Henderson Human Development Building  
814-863-2492

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Arnold, Bullington, Freeman, Gamm, Gunter, Hunt, Katkin, Mann, Meyer, Miller, Raffel, Ritti, Stuart, Vallance, Woolley, and Young.

*Graduate Faculty:* Associate Members Cirn, Eisele, Elliott, Ellis, Fisher, Fox, Goodstein, Guttenplan, Hussey, Hyman, Kramer, Lagoy, Lee, Mayers, Muller, Parsonage, Sawyer, and Vicary.

This interdisciplinary program provides instruction in content and research methods relating to the co-ordinated planning, development, administration, and evaluation of a range of community services in the three professional areas of health and medical care services, justice services, and community social services.

The aim of the program is to build the knowledge base and skills necessary to develop policies and programs for the effective delivery of human services to individuals and communities. Graduates of the program will be able to identify major community subsystems and recognize community problems and dysfunctions, expressing their relative seriousness in terms of economic and social costs. Graduates will have skill in working with members of the community and with community institutions to develop ways of coping with such problems and to facilitate the creation of interventions which will improve the quality of life. In addition, they will have the skills necessary to evaluate the effectiveness of these interventions.

The Ph.D. program prepares professionals, researchers, and teachers with the necessary conceptual and technical skills to identify and analyze elements of human service systems and to develop, implement, and evaluate programs designed to improve the quality of life. Ph.D. students will develop considerable understanding of all human service systems and might elect to develop a master's level competency in one of the professional areas represented in the program. The communication requirements for the Ph.D. can be satisfied by demonstration of proficiency through examination in a foreign language or a set of computer languages. The M.S. program will prepare individuals for professional-level work in health planning and administration, administration of justice, or community social services. Career opportunities include administration and planning positions in hospitals and health facilities, community mental health, social services, criminal justice planning agencies, courts, and corrections programs. A thesis is required for the M.S. degree.

Preference will be shown to applicants who have a broad background in the social sciences. Proficiency in quantitative skills such as mathematics and statistics is also desirable. In general, a 3.00 junior-senior average is expected of applicants, but consideration will be given to prior graduate education and professional work experience.

Special research and training facilities include the Institute for the Study of Human Development and the University Computation Center.

## COMMUNITY SYSTEMS PLANNING AND DEVELOPMENT (CSP D)

500. INTRODUCTION TO COMMUNITY SYSTEMS PLANNING AND DEVELOPMENT (3) Introduction to applied general systems theory; applications to analysis of community systems and to the planning of community human services.

501. HEALTH CARE ORGANIZATION (3) Examination of health systems, organization, financing, and evaluation; trends, problems, and issues.

505. UNDERSTANDING ORGANIZATIONAL BEHAVIOR (3) A systematic application of the principles of organizational behavior to understanding professional roles in human service organizations.

510. HEALTH PROBLEM ANALYSIS (3) Logic of empirical inquiry in study of community problems in health. Integration of theory and practice, technical data and values.

511. **APPROACHES TO HEALTH PLANNING (3)** A systematic exploration of approaches to health planning and an application of health planning techniques. Prerequisite: C.S.P.D. 510.
521. **VALUES AND GOALS IN THE ADMINISTRATION OF JUSTICE (3)** The justice system from perspective of clientele, service personnel, and the system. Meeting service requirements in community and institutional settings.
523. **ISSUES AND TRENDS IN THE DEVELOPMENT OF SOCIAL WELFARE SERVICES (3-6)** Examination of selected issues affecting the development of social welfare functions and services.
531. **COMMUNITY DYNAMICS AND SOCIAL SERVICES (3)** Classic and contemporary community organization theory, social planning and change, decision making, human services planning and action, community action, community research.
532. **INTERFACE PROBLEMS OF COMMUNITY SERVICE SYSTEMS (3)** Exploration of consequences of policy decisions and action in one or more social service systems on other community systems.
533. **BEHAVIORAL ASSUMPTIONS AND STRATEGIES IN THE PROCESS OF PLANNED CHANGE (3)** A general systems approach to the assumptions beneath various social problem strategies and consequences associated with each intervention-set.
534. **FORECASTING METHODS AND SOCIAL POLICY PLANNING (3)** Analysis of predictive methods for forecasting social change. Prerequisites: Econ. 405, Stat. 200.
540. **MANAGEMENT OF HEALTH SERVICES ORGANIZATIONS (3)** A systematic study of the roles of health services managers and the organizational and environmental context within which they work. Prerequisites: C.S.P.D. 505, 532.
542. **HOSPITAL AND HEALTH SERVICES ADMINISTRATION (3)** A study of decision making in hospitals and health organizations; the process of decision making, incorporating various techniques and strategies. Prerequisites: C.S.P.D. 501, 540, 545, Q.B.A. 521.
545. **FINANCIAL MANAGEMENT IN HEALTH INSTITUTIONS (3)** Financial environment of health institutions; financial aspects of management decision making; emphasis on revenue sources, budgeting, and cost control.
590. **COLLOQUIUM (1-3)**
596. **INDIVIDUAL STUDIES (1-6)**
597. **SPECIAL TOPICS (1-6)**
602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)**

## COMPARATIVE LITERATURE (C LIT)

CAROLINE D. ECKHARDT, *In Charge of Graduate Programs in Comparative Literature*  
N424 Burrowes Building  
814-863-0589

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Senior Members Begnal, Carrubba, Ebbinghaus, Frank, Hale, Kopp, Lewis, Lima, Peavler, Walden, Ward, Weintraub, and West.

*Graduate Faculty:* Associate Members Balaban, Eckhardt, Fitz, Grecco, Hale, and Knight.

Programs of study combine a core of comparative literature courses with courses in several national literatures (two for the master's degree and three for the doctoral degree) according to the student's interests. These programs can be designed to concentrate on such topics as genres, themes, periods, movements, folklore, criticism, the influence of literary works, and the relationships among national literatures and between literature and other disciplines.

Requirements for the M.A. degree include (1) 9 credits in comparative literature (3 credits of which must be C.Lit. 501), 9 credits in one national literature, and 6 credits in a second national literature; (2)



proficiency in two foreign languages; (3) a written comprehensive examination based on a reading list; and (4) 6 thesis credits.

Students with a 3.00 junior-senior average and appropriate course backgrounds (including preparation in a foreign language) will be considered for admission to the master's program. Exceptions may be made for students with special backgrounds and abilities.

Requirements for the Ph.D. degree include (1) 9 credits in comparative literature (C.Lit. 501, 502, and 503, unless these have been part of the M.A. degree program) and at least 21 credits in either a concentration in national literatures or a concentration in a period, genre, theme, or area study; (2) an oral candidacy examination; (3) proficiency in three foreign languages; (4) a written comprehensive examination based on a reading list; and (5) a thesis.

Students holding or completing a master's degree in an appropriate field, and prepared to work in three national literatures, will be considered for admission to the doctoral program.

## COMPARATIVE LITERATURE (C LIT)

400. SENIOR SEMINAR IN COMPARATIVE LITERATURE (3)
401. WESTERN LITERATURE I (3) *Eckhardt and Knight*
402. WESTERN LITERATURE II (3) *Knight and Condee*
403. WESTERN LITERATURE III (3) *Begnal and Peavler*
407. LITERATURE OF VOYAGE, TRAVEL, AND DISCOVERY (3) *Martin*
408. HEROIC EPIC AND SONG (3) *Bayard, Thigpen, and Bowden*
422. AFRICAN DRAMA (3) *Hale*
423. AFRICAN NOVEL (3) *Hale*
443. (Ger. 443) LITERARY RELATIONS OF GERMANY WITH ENGLAND AND AMERICA (3-9) *Kopp and Lewis*
470. OLD MASTERS OF THE MODERN NOVEL (3) *Begnal and Ward*
480. INTRODUCTION TO FOLKLORE (3) *Thigpen*
483. (Thea. 483) FILM AND LITERATURE (3)
486. TRAGEDY (3) *Grecco and Lima*
487. COMEDY (3) *Knight and Lima*
488. (Engl. 488) MODERN CONTINENTAL DRAMA (3) *Grecco*
496. INDEPENDENT STUDIES (1-12)
497. SPECIAL TOPICS (1-6)
  
500. SEMINAR IN COMPARATIVE LITERATURE (3-6)
501. COMPARATIVE METHOD IN LITERARY STUDIES (3) Bibliography, research methods, and studies in comparative literature. *Eckhardt and Ward*
502. COMPARATIVE CRITICISM I: CLASSICAL TO NEOCLASSICAL (3) Issues in literary criticism from Plato and Aristotle to the mid-eighteenth century. *Ward*
503. COMPARATIVE CRITICISM II: ROMANTIC TO CONTEMPORARY (3) Principles and theories of literary criticism from eighteenth- and nineteenth-century beginnings to twentieth-century expansion and application. *Ward*
508. NORSE AND GAELIC SAGAS (3) Medieval Irish and Scandinavian prose tales surveyed and compared with respect to background, development, themes, and characteristics. *Bayard and Ebbinghaus*
570. FORCES IN CONTEMPORARY EUROPEAN LITERATURE (3) The intellectual currents that have influenced European writers of the mid-twentieth century: Beckett, Böll, Robbe-Grillet, and others. *West*
588. TWENTIETH-CENTURY DRAMA (3) The comparative analysis of major plays of the twentieth century. *Grecco and Lima*
593. (Engl. 593) ANGLO-AMERICAN FOLK SONG (3) Survey of relevant literary and ethnological scholarship and field work, European and American, from the early sixteenth century to the present. *Bayard*
596. INDIVIDUAL STUDIES (1-6)

## COMPUTER SCIENCE (CMPSC)

JOSEPH M. LAMBERT, *Acting Head of the Department*  
303 Whitmore Laboratory  
814-865-9505

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members deMaine, Goldstine, D. Johnson, and Laird.

*Graduate Faculty:* Associate Members Alt, Frederickson, Heller, Irwin, Ja'Ja', G. Johnson, Lambert, Laskowski, Sakoda, Simon, Spirn, Wall, and Wotschke.

The department offers courses and is prepared to direct research in a variety of subfields of computer science, including data bases and information retrieval, foundations of computer science, analysis of algorithms, computational complexity, formal language theory, operating systems, and numerical analysis. Research and instruction are supported by extensive computing facilities in the University's Computation Center and by the Computer Systems Laboratory operated by the department.

Admission to the M.S. program without deficiency requires that an applicant should have completed at least 9 credits of computer science at the advanced undergraduate level from the areas of data structures, programming languages and compiler design, computer organization and operating systems, numerical analysis, and language and automata theory. In addition, the student is expected to have mathematics training which includes calculus, linear algebra, and some discrete mathematics.

The M.S. candidate must satisfactorily complete the requirements of the Graduate School. In addition, at least 12 of the required 500-level credits shall be regular courses in the Department of Computer Science meeting certain distribution requirements described in the departmental brochure, *Graduate Study in Computer Science at Penn State*. The nonthesis option is available for the M.S. degree. The candidate may also be required to demonstrate proficiency in the design and implementation of computer programs or computer-related systems, or both.

The Ph.D. degree is primarily a research degree and is conferred on the basis of original work and high academic achievement in computer science. In order to be accepted as a candidate the student must pass a written candidacy examination. The communication and foreign language requirement for the Ph.D. degree may be satisfied by a proficiency in one foreign language (French, German, or Russian). These and additional requirements are detailed in the departmental brochure cited above.

Students with at least a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. The department requires scores on the Graduate Record Examination Aptitude Test from all applicants.

Students in this program may elect the dual-title degree program option in operations research for the Ph.D. and M.S. degrees (see p. 249).

### COMPUTER SCIENCE (CMPSC)

- 400. PROGRAMMING LANGUAGE CONCEPTS (3)
- 402. INTRODUCTION TO COMPUTER PROGRAMMING (3)
- 404. INFORMATION STRUCTURES (3)
- 408. (Chem. 408) COMPUTER APPLICATIONS IN CHEMISTRY (3)
- 410. COMPUTER ORGANIZATION AND OPERATION (3)
- 411. OPERATING SYSTEMS (3)
- 415. (E.E. 415) COMPUTER SYSTEMS ARCHITECTURE (3)
- 420. COMPILER CONSTRUCTION (3)
- 430. COMBINATORICS AND GRAPH THEORY (3)
- 440. INTRODUCTION TO DATABASE MANAGEMENT SYSTEMS (3)
- 442. ADVANCED PROGRAMMING AND JOB CONTROL LANGUAGE (3)
- 444. SYSTEMS AND PROGRAM DESIGN IN EDP (3)
- 453. (Math. 453) NUMERICAL COMPUTATIONS (3)



- 454. (Math. 454) MATRIX COMPUTATIONS (3)
- 468. MATHEMATICAL MACHINE THEORY (3)
- 491. COMPUTER PROJECTS (1-12)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

500. THEORY OF AUTOMATA (3) The structure of finite automata and sequential machines including characterization theorems, minimization problems, state identification experiments, and decomposition theory. Prerequisite: Cmp.Sc. 468.

510. PARSING, TRANSLATION, AND COMPILING (3) Principles of compiler design: lexical analysis, parsing methods, semantic analysis, code generation, and optimization. Prerequisites: Cmp.Sc. 420, 468.

511. OPERATING SYSTEMS (3) Concurrent processes, synchronization and deadlock, scheduling models, queueing models, memory management, and security. Prerequisites: Cmp.Sc. 411; Stat. (Math.) 418.

515. ARCHITECTURE OF ARITHMETIC PROCESSORS (3) Algorithms and techniques for designing arithmetic processors; conventional algorithms and processor design; high-speed algorithms and resulting architectural structures. Prerequisite: Cmp.Sc. 415.

530. MACHINE INTELLIGENCE AND HEURISTIC PROGRAMMING (3) Methods for making machines behave intelligently; problem solving, theorem proving, game playing, question answering, learning, induction; specialized languages and data structures. Prerequisite: Cmp.Sc. 420.

534. ALGORITHM DESIGN AND ANALYSIS (3) Data structures and programming techniques useful in the design of efficient algorithms; algorithm analysis; computational complexity. Prerequisite: Cmp.Sc. 404.

535. THEORY OF GRAPHS AND NETWORKS (3) Theory and applications of graphs including structure of graphs, network analysis, and algorithms for computer solution of graph-theoretic problems. Prerequisite: Cmp.Sc. 430.

537. (B.A. 537) MANAGEMENT INFORMATION SYSTEMS DESIGN (3) Cost, value, and technical considerations in analysis and design of information systems whose purposes are to aid decision making in organizations.

539. COMPLEXITY OF COMBINATORIAL PROBLEMS (3) NP-completeness theory; approximation and heuristic techniques; discrete scheduling; additional complexity classes. Prerequisite: Cmp.Sc. 430 or 534.

540. INFORMATION PROCESSING SYSTEMS (3) Data structures and data processing; information retrieval systems. Prerequisites: Cmp.Sc. 411, 440.

545. INFORMATION RETRIEVAL (3) Input-output, design, implementation, evaluation, global memories, and comparison of information retrieval systems. Prerequisite: Cmp.Sc. 540.

551. (Math. 551) NUMERICAL ALGEBRA (3) Zeros of polynomials; iterative solution of linear and nonlinear systems; sparse matrix techniques; eigenvalues and eigenvectors. Prerequisite: Cmp.Sc. 454 or Math. 441.

552. (Math. 552) INTRODUCTION TO APPROXIMATION THEORY (3) Interpolation; remainder theory; approximation of functions; error analysis; orthogonal polynomials; approximation of linear functionals; functional analysis applied to numerical analysis. Prerequisites: Math. 420, 3 credits in computer science.

553. (Math. 553) NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS (3) Methods for initial value and boundary value problems. Stability and convergence analysis, automatic error control, and stiff systems. Prerequisites: Cmp.Sc. 453, Math. 431.

559. COMPUTABILITY AND RECURSIVE FUNCTIONS (3) Mathematical treatment of computability, recursive functions, Turing machines, unsolvable problems, recursive and recursively enumerable sets. Prerequisite: Cmp.Sc. 468.

564. (Math. 564) NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS (3) Methods of parabolic, hyperbolic, and elliptic partial differential equations; finite difference and variational methods; splines, finite elements. Prerequisites: Cmp.Sc. 453, 454; A.M. (Math.) 451 or 432.

568-569. THEORY OF FORMAL LANGUAGES AND AUTOMATA (3 each) Generation and recognition of formal languages, grammars, Chomsky's hierarchy of languages, closure properties, characterization by automata, algebraic properties, complexity classification. Prerequisite: Cmp.Sc. 468.

579. (Math. 579) SPECIAL TOPICS IN NUMERICAL ANALYSIS (2-12)

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

## COUNSELOR EDUCATION (CN ED)

EDWIN L. HERR, *Head of the Division of Counseling and Educational Psychology*  
201 Carpenter Building  
814-865-3427

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Senior Members Baker, Britton, Herr, Horan, Hudson, Keat, Kelz, and Swisher.

*Graduate Faculty:* Associate Members Craighead, Moore, and Scofield.

Professional preparation is offered at the master's level for school counselors (elementary and secondary), college counselors or persons entering college student personnel services, and rehabilitation counselors. Doctoral programs prepare candidates for positions of responsibility and leadership in these same areas, as well as in the education of counselors and in counseling research and practice. Doctoral candidates must have a minimum of one year of work experience in their field.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by a comprehensive knowledge of one foreign language and courses from other designated areas, or by options from designated areas selected to include competence in statistics, research design, computer application, or electronic data processing.

All candidates for graduate degrees in counselor education must present for admission at least 27 undergraduate credits of 3.00 or better, distributed among at least three of the following areas: economics, education, psychology, sociology, and physiology or anatomy.

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests. Doctoral candidates should present at least a 3.33 average in all graduate study completed.

All candidates are expected to exhibit, in addition to academic competence, effectiveness in interpersonal relations and in both written and oral communication. They must also evidence support of professional counseling activities and organizations.

## COUNSELOR EDUCATION (CN ED)

403. FOUNDATIONS OF GUIDANCE AND COUNSELING PROCESSES (3)

404. GROUP PROCEDURES IN GUIDANCE AND COUNSELING (3)

408. INTRODUCTION TO VOCATIONAL REHABILITATION (3)

409. MEDICAL INFORMATION FOR COUNSELORS (3)

410. REHABILITATION OF THE MENTALLY ILL (3)

412. REHABILITATION FACILITIES AND SERVICES OF PENNSYLVANIA (3)

413. REHABILITATION CASE RECORDING AND MANAGEMENT (3)

415. COUNSELING ADULTS (3)

417. (Voc.Ed. 417v) CAREER EDUCATION: ORIGINS, THEORY, IMPLEMENTATION (3)



425. THE USE OF TESTS IN COUNSELING (3)
470. WORKSHOP IN STUDIES IN COUNSELOR EDUCATION (1-6)
496. INDEPENDENT STUDIES (1-12)
497. SPECIAL TOPICS (1-6)
501. COUNSELING THEORY AND METHOD (3) Theory and methods of counseling individuals whose problems of choice, decision, and adjustment fall within the normal range.
502. ADVANCED COUNSELING THEORY AND METHOD (3) Assessment, intervention, and evaluation procedures for counseling problems frequently encountered in school, college, and rehabilitation settings. Prerequisite: Cn.Ed. 501.
503. GUIDANCE SERVICES IN ELEMENTARY EDUCATION (3) Guidance services to elementary school students; guidance opportunities for elementary teachers and principals.
504. GUIDANCE SERVICES IN SECONDARY EDUCATION (3) Nature and scope of guidance in secondary schools — services, models, and strategies; the counselor as an agent of change.
505. FOUNDATIONS OF COUNSELING INFORMATION (3) Accelerating change in economic, psychological, social, educational influences upon counselees. Utilization of information systems in effecting counselee change.
506. INDIVIDUAL ANALYSIS AND COUNSELING PROCEDURES (3) Collection and use of data basic to the counselor's understanding of individuals; the counseling interview and techniques other than testing. Prerequisites: Cn.Ed. 425, 501, 505.
507. COUNSELING PRACTICUM (1-6) Practice in the application of guidance principles and methods to cases counseled under supervision; case conferences; seminar in guidance techniques. Prerequisite: Cn.Ed. 506.
508. ORGANIZATION AND ADMINISTRATION OF GUIDANCE PROGRAMS (3) Principles, organization, personnel, functions, integration with school programs, evaluation.
509. CONTRIBUTIONS OF PROFESSIONAL PERSONNEL TO VOCATIONAL REHABILITATION (3) Contributions of medical, social, psychological, and other specialists through the team approach; professional ethics, medical problems. Prerequisites: Cn.Ed. 403, 408.
511. SUPERVISED PRACTICUM IN REHABILITATION COUNSELING (1-6) Application of principles and techniques of rehabilitation counseling to cases involving handicapped individuals. Prerequisites: Cn.Ed. 403, 408.
512. PROFESSIONAL EXPERIENCE IN REHABILITATION COUNSELING (1-10) Supervised internship with responsibility for a regular case load. Prerequisites: Cn.Ed. 403, 409, 501, 507.
513. SUPERVISION OF COUNSELORS (3-9) Practical experience in supervising and evaluating work of counselors. Prerequisite: Cn.Ed. 507.
516. EVALUATION OF PROJECTS IN SCHOOL GUIDANCE (2-6) Implementation and evaluation of program development projects in cooperation with state or local guidance programs. Prerequisite: 15 credits in counselor education.
517. ELEMENTARY SCHOOL COUNSELING INTERNSHIP AND SEMINAR (1 per term, maximum of 3) Off-campus, supervised internships in elementary school settings with supplementary related topics, discussion, and skills training in on-campus seminars. Prerequisite: Cn.Ed. 503.
518. SECONDARY SCHOOL COUNSELING INTERNSHIP AND SEMINAR (1 per term, maximum of 3) Off-campus, supervised internships in secondary school settings with supplementary related topics, discussion, and skills training seminars. Prerequisite: Cn.Ed. 504.
519. STUDENT PERSONNEL INTERNSHIP AND INTEGRATIVE SEMINAR (1-3 per term, maximum of 9) Off-campus, supervised internships in postsecondary-related college-student personnel settings with pertinent topics, discussion; skills training seminars on campus. Prerequisite: Cn.Ed. 551.
551. STUDENT PERSONNEL SERVICES (2-3) Student personnel services in higher education; organization of student advisory programs; use of personnel data; cocurricular activities; student welfare.

553. **STUDENT PERSONNEL SERVICES PROGRAMMING (2-3)** Formulation of policies as guides to the student personnel service programs; integration of program elements; research; current problems and trends. Prerequisites: Cn.Ed. 551, Hi.Ed. 545.

555. **CAREER COUNSELING (3)** The examination of historical, legislative, and current models of career counseling and the development of pertinent individual and group techniques. Prerequisite: Cn.Ed. 505.

591. **SEMINAR IN COUNSELING: HISTORY AND TRENDS (1)** Discussion of the history of guidance and counseling, emphasizing how the past has shaped the present and portends the future. Prerequisite: 9 credits in counselor education.

592. **SEMINAR IN COUNSELING: LEGAL AND ETHICAL CONCERNS (1-2)** Study and discussion of legal, ethical, and professional concerns of counselors; privileged communication, data banks, and privacy invasion. Prerequisite: 9 credits in counselor education.

593. **SEMINAR IN COUNSELING: PHILOSOPHY (1)** Study and discussion of such philosophical foundations of counseling as phenomenology, idealism, realism, existentialism, and daseinanalytic, theological, and other contemporary thoughts. Prerequisite: 9 credits in counselor education.

596. **INDIVIDUAL STUDIES (1-6)**

597. **SPECIAL TOPICS (1-6)**

602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)**

## CURRICULUM AND INSTRUCTION (C I)

CAROL A. CARTWRIGHT, *In Charge of Graduate Programs in Curriculum and Instruction*  
155 Chambers Building  
814-865-5433

Degrees Conferred: Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Senior Members Alessandro, Askov, Bell, Bixby, Bliesmer, Brewer, Cartwright, M. Dupuis, V. Dupuis, Dwyer, Fagan, Fowler, Golub, Heilman, Heimer, Hermanowicz, Koble, Madsen, Nelson, Searles, Shemick, Short, Shrigley, Szabo, Trueblood, Welliver, Withall, F. Wood, Yawkey, and Zaffroni.

*Graduate Faculty:* Associate Members Goldsberry, Hogg, Johnson, Marbach, Nicely, Prewitt-Díaz, Sharp, and Streibel.

This program provides advanced professional preparation in the special areas of supervision and curriculum development, bilingual education, early childhood education, elementary education, instructional media, language arts and reading, science education, social studies education, and mathematics education. Candidates for the Ph.D. and D.Ed. degrees must meet all requirements, described in the earlier sections of this catalog. To meet residency requirements, the Ph.D. candidate must spend at least three consecutive terms enrolled as a full-time student at the University Park Campus. The D.Ed. candidate must spend at least three of any five consecutive terms enrolled as a full-time student at the University Park Campus.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by options selected from designated areas including, but not restricted to, foreign languages.

Candidates for the D.Ed. degree with a minor in curriculum and instruction must take a minimum of 15 course credits approved in advance by the person in charge of graduate programs in curriculum and instruction. Candidates for the M.Ed. degree with a minor in curriculum and instruction must take a minimum of 6 course credits approved in advance.

For admission to the professional degrees of M.Ed. and D.Ed., teaching or equivalent experience and at least 18 credits in education are recommended. Students with a 2.75 junior-senior average and with appropriate course and professional backgrounds will be considered for admission, subject to the limitation of program facilities.



**CURRICULUM AND INSTRUCTION (C I)**

- 400. INTRODUCTION TO RESEARCH LITERATURE (3)
- 410. SECONDARY TEACHING I (2)
- 411. SECONDARY TEACHING II (2)
- 412. SECONDARY TEACHING III (2)
- 413. CLINICAL APPLICATION OF INSTRUCTION AND MANAGEMENT SKILLS (2 per term, maximum of 6)
- 414. PRACTICUM IN STUDENT TEACHING — N-12 (12)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

**CURRICULUM AND SUPERVISION (C & S)**

- 401. MEASUREMENT AND EVALUATION OF INSTRUCTION, K-12 (3)
- 405. STRATEGIES IN CLASSROOM MANAGEMENT (3)
- 451. INSTRUCTION IN EARLY CHILDHOOD EDUCATION DERIVED FROM DEVELOPMENTAL THEORIES (3)
- 452. ANALYSIS OF MODEL EARLY CHILDHOOD EDUCATION PROGRAMS (3)
- 454. (I.F.S. 454) DEVELOPMENT AND ADMINISTRATION OF CHILD SERVICE PROGRAMS (3)
- 470. WORKSHOP IN SELECTED STUDIES IN CURRICULUM (1-6)
- 471. WORKSHOP IN SELECTED STUDIES IN SUPERVISION (1-6)
- 478. THE YOUNG CHILD'S PLAY AS EDUCATIVE PROCESSES I (3)
- 490. (Human. 490) HUMANITIES FOR TEACHERS (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 571. SEMINAR IN CONTEMPORARY ISSUES IN ELEMENTARY EDUCATION (1-3) Conferences and discussions designed to meet the needs of experienced teachers and principals in the field of elementary education. Prerequisites: 6 credits in elementary education and teaching experience.
- 572. ISSUES AND TRENDS IN EARLY CHILDHOOD EDUCATION (3) Research, experimental programs, and emerging trends in early childhood education; relationships between educational experiences and later intellectual and emotional development. Prerequisites: C.&S. 452, Ed.Psy. 400.
- 573. ORGANIZATION OF THE ELEMENTARY SCHOOL CURRICULUM (3) Principles underlying curriculum construction. Primarily for elementary education majors. Prerequisite: C.I. 414 or teaching experience.
- 575. ORGANIZATION OF THE SECONDARY SCHOOL CURRICULUM (3) Functions of laymen, pupils, teachers, supervisors, and administrators in secondary school curriculum construction. Prerequisites: 12 credits in education and psychology, and teaching experience.
- 576. CURRICULUM THEORY K-12 (3) The analysis and use of the foundations which underlie models of curriculum design. Prerequisite: C.&S. 573 or 575.
- 577. SEMINAR IN CURRICULUM RESEARCH (3) Seminar designed to meet the need for special study of particular research projects in elementary and secondary education. Prerequisite: 12 credits of graduate work in education.
- 578. STANDARD WORKS IN CURRICULUM AND INSTRUCTION (3) Study of significant empirical, historical, evaluative, philosophical, and critical works having an impact on curriculum and instruction practice. Prerequisite: C.&S. 576.

580. **SUPERVISION OF STUDENT TEACHERS (3)** A course in supervision for master teachers, department heads, and college teachers with supervisory responsibilities in teacher education. Prerequisites: teaching experience and 18 credits in education including at least 5 in methods.
581. **PRINCIPLES OF INSTRUCTIONAL SUPERVISION (3)** Social and institutional settings for instructional supervision; functions, activities, and practices of supervision; supervisory case studies.
582. **SYSTEMATIC OBSERVATION OF INSTRUCTION (3)** Construction and use of valid and reliable systematic observation systems used as a basis for classroom observation of instruction. Prerequisite: student teaching or teaching experience.
583. **INTERNSHIP IN CURRICULUM AND SUPERVISION (3-6)** Internship in schools or educational facilities where student is not employed, under supervision of graduate faculty in student's major area.
596. **INDIVIDUAL STUDIES (1-6)**
597. **SPECIAL TOPICS (1-6)**

### **INDUSTRIAL ARTS EDUCATION (IA ED)**

460. **PLANNING AND MANAGEMENT OF INSTRUCTIONAL RESOURCES (3)**
461. **CONSTRUCTION ACTIVITIES IN THE ELEMENTARY SCHOOL (3)**
462. **PROBLEMS IN INDUSTRIAL ARTS (2)**
464. **CURRICULUM AND INSTRUCTION: INDUSTRIAL STUDIES (3)**
465. **PREPROFESSIONAL EXPERIENCE IN INDUSTRIAL STUDIES (1-3)**
496. **INDEPENDENT STUDIES (1-12)**
497. **SPECIAL TOPICS (1-6)**
561. **HISTORY AND PHILOSOPHY OF INDUSTRIAL ARTS (2-3)** Historical developments and concurrent educational philosophies of industrial arts in American education.
562. **CURRICULUM DEVELOPMENT IN INDUSTRIAL ARTS EDUCATION (2-3)** Analysis of curriculum innovations in industrial arts and cognate fields; strategies for implementing curricular change; construction and assessment of curriculum materials. Prerequisite or concurrent: I.A.Ed. 561. Prerequisite: teaching experience.
563. **SUPERVISION AND ADMINISTRATION OF INDUSTRIAL ARTS EDUCATION (2-3)** How to organize, supervise, and administer functioning programs of industrial arts; duties of a supervisor and director of industrial arts. Prerequisite or concurrent: I.A.Ed. 562. Prerequisite: teaching experience.
564. **EVALUATION IN INDUSTRIAL ARTS (2-3)** Construction of informal manipulative and written tests; use of standardized mechanical aptitude tests; construction and use of performance rating scales. Prerequisite: C.I. 400 or C.&S. 401.
568. **RESEARCH IN INDUSTRIAL ARTS (2-3)** Research techniques in industrial arts education. Prerequisite or concurrent: C.I. 400.
569. **SEMINAR IN INDUSTRIAL ARTS (1-9)** Directed intensive study, investigation, or research in selected phases of the program; reports and constructive criticism. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.

### **INSTRUCTIONAL SYSTEMS (INSYS)**

411. **ORIENTATION TO INSTRUCTIONAL SYSTEMS (2)**
412. **PRODUCTION AND UTILIZATION OF GRAPHIC STIMULUS MATERIALS (3)**
413. **PRODUCTION OF EDUCATIONAL MOTION PICTURES (3)**
414. **TELEVISION IN EDUCATION (3)**
415. **SYSTEMATIC INSTRUCTIONAL DEVELOPMENT (3)**
425. **INSTRUCTIONAL SYSTEMS DESIGN I (3)**
430. **COMPUTERS IN INSTRUCTION (3)**
496. **INDEPENDENT STUDIES (1-12)**
497. **SPECIAL TOPICS (1-6)**



511. ORGANIZATION AND ADMINISTRATION OF MEDIA IN SCHOOLS (3) Problems of providing instructional media in schools; the role of the media consultant in curriculum construction. Prerequisite: In.Sys. 411.

525. INSTRUCTIONAL SYSTEMS DESIGN II (3) Advanced rational and empirical methods of analyzing and designing instructional systems. Prerequisites: In.Sys. 425 and a course in research methods.

532. SURVEY OF MEDIA RESEARCH (3) Systematic study of media research in educational applications of television, still and motion pictures, graphic and simulated environments. Prerequisite: Ed.Psy. 400.

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

### **MATHEMATICS EDUCATION (MTHED)**

410. TEACHING SECONDARY MATHEMATICS I (1)

411. TEACHING SECONDARY MATHEMATICS II (2)

412. TEACHING SECONDARY MATHEMATICS III (3)

420. TEACHING MATHEMATICS IN THE ELEMENTARY SCHOOLS (3)

422. INDIVIDUALIZING INSTRUCTION IN SCHOOL MATHEMATICS (3)

424. CONTEMPORARY ELEMENTARY SCHOOL MATHEMATICS PROGRAMS (3)

425. CONTEMPORARY SECONDARY SCHOOL MATHEMATICS PROGRAMS (3)

427. COMPUTERS AND THE TEACHING OF MATHEMATICS (3)

470. SELECTED STUDIES IN MATHEMATICS EDUCATION (1-6)

496. INDEPENDENT STUDIES (1-12)

497. SPECIAL TOPICS (1-6)

520. ANALYSIS OF RESEARCH IN MATHEMATICS EDUCATION (3) Survey of the status of knowledge about mathematics learning and instruction, K-12; analysis of research procedures; instruments for evaluating research. Prerequisites: Mth.Ed. 420 or 412, 3 credits in statistics, and teaching experience.

521. STRATEGIES FOR RESEARCH IN MATHEMATICS EDUCATION (3) In-depth analysis of strategies for research in mathematics education; conditions for applying the scientific model; implications for research and development. Prerequisite: Mth.Ed. 520.

525. RESEARCH PARTICIPATION IN SCHOOL MATHEMATICS CURRICULUM CONSTRUCTION (3) Development of theoretical bases for the construction of instructional materials in mathematics, research participation in preparing and testing curriculum materials. Prerequisite: Mth.Ed. 521.

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

### **READING, COMMUNICATION, AND LANGUAGE EDUCATION (RCLED)**

400. TEACHING READING IN THE ELEMENTARY SCHOOL (3)

401. METHODS OF TEACHING LANGUAGE ARTS IN ELEMENTARY SCHOOL (3)

402. TEACHING CHILDREN'S LITERATURE (3)

410. TEACHING SECONDARY ENGLISH I (1)

411. TEACHING SECONDARY ENGLISH II (2)

412. TEACHING SECONDARY ENGLISH III (3)

420. TEACHING READING AND LITERATURE TO ADOLESCENTS (3)

424. SEMINAR IN FOREIGN LANGUAGE AND BILINGUAL EDUCATION (3)

440. FUNDAMENTALS OF READING INSTRUCTION (3)

442. THE ELEMENTARY SCHOOL LANGUAGE ARTS PROGRAM (3)

443. TEACHING LANGUAGE AND COMPOSITION (3)

445. TEACHING ENGLISH IN BILINGUAL/DIALECTAL EDUCATION (3)

446. REMEDIAL READING IN THE CLASSROOM (3)

- 450. CONTENT AREA READING (3)
- 467. INTERGROUP STORYTELLING (3)
- 470. SELECTED STUDIES IN READING, COMMUNICATION, AND LANGUAGE EDUCATION (1-6)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 526. (Ed.Psy. 526) THE PSYCHOLOGY OF READING (3) Psychological principles underlying the process of reading and comprehending with application to instruction. Prerequisite: Ed.Psy. 421.
- 540. TEACHING READING: LINGUISTICS PERSPECTIVE (3) Examination of reading as language and thought processes; contributions of linguistics, orthography, semantics, and syntax to instructional strategies. Prerequisites: undergraduate reading course and teaching experience.
- 541. CHILDREN'S LITERATURE RELATED TO ETHNIC AND SOCIAL ISSUES (3) Children's literature, K-12; study of literary symbolism, ethnic literature, and controversial issues; bibliotherapy, censorship, sex education through the trade book. Prerequisite: RCLEd. 402.
- 542. ISSUES IN READING, COMMUNICATION, AND LANGUAGE EDUCATION (3 per term, maximum of 6) Issues in curriculum development and research in reading, communication, and language education, K-12, instructional materials analysis, and development. Prerequisites: RCLEd. 412 and teaching experience.
- 543. RESEARCH IN THE TEACHING OF READING, COMMUNICATION, AND LANGUAGE EDUCATION (3 per term, maximum of 6) Cooperative study of problems and research findings in the teaching of reading, communication, and language education in American schools. Prerequisite: RCLEd. 412 and teaching experience.
- 545. DIAGNOSTIC TESTING IN READING (3) Practicum in diagnosing reading difficulties, elementary and secondary levels; achievement, diagnostic, and capacity tests; informal inventories; genesis of reading problems. Prerequisite: RCLEd. 440.
- 550. THEORY AND PRACTICUM IN REMEDIAL READING FOR ELEMENTARY STUDENTS (3) Supervised practicum with young children where remediation designs are analyzed, applied, and evaluated. Prerequisites: RCLEd. 440 or equivalent teaching experience, and RCLEd. 545.
- 551. THEORY AND PRACTICUM IN REMEDIAL READING FOR SECONDARY/ADULT LEARNERS (3) Supervised practicum work with secondary/adult/remedial students based upon theories and research concerning the reading problems of young adults. Prerequisite: RCLEd. 550.
- 557. PRACTICUM: REMEDIAL PROCEDURES AND DIAGNOSIS (3-6) Advanced practicum; diagnostic testing and remedial instruction of more severe types of reading disability; newer and special materials and procedures. Prerequisite: RCLEd. 545.
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)

## SCIENCE EDUCATION (SCIED)

- 410. TEACHING SECONDARY SCIENCE I (1)
- 411. TEACHING SECONDARY SCIENCE II (2)
- 412. TEACHING SECONDARY SCIENCE III (3)
- 454. SCIENCE IN EARLY CHILDHOOD EDUCATION (3)
- 455. FIELD NATURAL HISTORY FOR TEACHERS (3)
- 456. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE SCHOOLS (3)
- 457. TEACHING OF ENVIRONMENTAL EDUCATION IN THE SCHOOLS (3)
- 458. TEACHING SCIENCE IN THE ELEMENTARY SCHOOL (3)
- 470. SELECTED STUDIES IN SCIENCE EDUCATION (1-6)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)



556. **THE SUPERVISION OF SCIENCE CURRICULUM (3)** Supervision of elementary and secondary science teachers as they develop K-12 programs in the public schools. Prerequisites: 6 credits in science methods, 20 credits in science or equivalent, and teaching experience.

557. **(Biol. 557) WORKSHOP IN THE BIOLOGICAL SCIENCES (3)** Projects designed for teachers of biology in the secondary schools.

558. **RESEARCH PROBLEMS IN SCIENCE TEACHING (3)** Problems and research dealing with curriculum, materials, evaluation, and supervision of science teaching and learning. Prerequisites: Sci.Ed. 412 or 458, and teaching experience.

559. **ANALYSIS OF INSTRUCTION IN ELEMENTARY SCIENCE EDUCATION (3)** Analysis of the history, issues, trends, and research in elementary science education. Prerequisites: teaching experience, 3 credits in elementary science methods, and 18 credits of science courses.

596. **INDIVIDUAL STUDIES (1-6)**

597. **SPECIAL TOPICS (1-6)**

### **SOCIAL STUDIES EDUCATION (SS ED)**

410. **TEACHING SECONDARY SOCIAL STUDIES I (1)**

411. **TEACHING SECONDARY SOCIAL STUDIES II (2)**

412. **TEACHING SECONDARY SOCIAL STUDIES III (3)**

430. **TEACHING SOCIAL STUDIES IN THE ELEMENTARY GRADES (2-3)**

432. **THE SOCIAL SCIENCES IN THE SOCIAL STUDIES CURRICULUM (2-3)**

470. **ISSUES IN SOCIAL STUDIES EDUCATION (1-6)**

496. **INDEPENDENT STUDIES (1-12)**

497. **SPECIAL TOPICS (1-6)**

530. **INSTRUCTIONAL PRACTICES IN THE SOCIAL STUDIES (3)** Social studies innovations in the classroom, new programs, new materials, new methods, and evaluation. Prerequisite: one year of teaching experience.

533. **RESEARCH IN THE TEACHING OF SOCIAL STUDIES (3)** Procedures and methods of research for the teaching of social studies, strategies of investigation and review of research literature. Prerequisites: 12 credits in the social sciences on the 400 or 500 level and teaching experience.

596. **INDIVIDUAL STUDIES (1-6)**

597. **SPECIAL TOPICS (1-6)**

### **DAIRY SCIENCE (D SC)**

PAUL J. WANGSNESS, *Head of the Department of Dairy and Animal Science*  
324 Animal Industries Building  
814-865-1362

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Almquist, Flipse, Hargrove, Kesler, McCarthy, Muller, Senger, and Tanabe.

*Graduate Faculty:* Associate Members Adams, Shellenberger, Specht, Sweeney, and Thoele.

Students may specialize in dairy cattle nutrition, metabolism, dairy cattle genetics, dairy cattle management, and physiology of reproduction. A minor program generally is taken in agricultural economics, animal nutrition, biochemistry, genetics, physiology, or statistics. The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of one foreign language or communication skills.

Prerequisite to graduate work is the completion of an undergraduate major in animal industry, animal science, dairy science, or a related area. The undergraduate program must include mathematics and general physics. Students may be admitted with limited deficiency but are required to make up undergraduate deficiency work without degree credit.

Students with a 2.80 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.80 grade-point average may be made for students with special backgrounds, abilities, and interests. The Graduate Record Examination is required of all applicants.

## DAIRY SCIENCE (D SC)

- 410. DAIRY HERD MANAGEMENT (4) *Muller*
- 423. ADVANCED DAIRY CATTLE JUDGING (1 per term, maximum of 2)
- 427. MILK SECRETION (3) *Kesler*
- 431. PHYSIOLOGY OF REPRODUCTION IN FARM ANIMALS (3) *Senger*
- 490. COLLOQUIUM (1)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 507. DAIRY CATTLE MANAGEMENT (1-6)
- 511. DAIRY CATTLE NUTRITION (1-6) Nutritional requirements of dairy cattle. Prerequisite: A.Ntr. 401.
- 512. ADVANCED STUDIES IN MILK SECRETION (1-6) Physiology of milk secretion. Prerequisite: D.Sc. 427. *Kesler*
- 513. DAIRY CATTLE BREEDING (1-6) Interpretation and application of current knowledge in genetics to dairy cattle breeding and selection. Prerequisites: An.Sc. 322, Biol. 422, 3 credits in statistics. *Hargrove*
- 515. ADVANCED PHYSIOLOGY OF REPRODUCTION IN FARM ANIMALS (1-6) *Almquist*
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## DEVELOPMENTAL AND REMEDIAL READING (D R R)

CAROL A. CARTWRIGHT, *In Charge of Graduate Program in Developmental and Remedial Reading*  
 155 Chambers Building  
 814-865-5433

*Degree Conferred:* M.Ed.

*Graduate Faculty:* Senior Members Askov, Bliesmer, Cartwright, M. Dupuis, Fagan, Golub, Heilman, and Madsen.

The purpose of the master's program is to prepare classroom teachers in elementary and secondary schools for more effective teaching of reading and to provide preparation for supervisory and administrative positions relative to reading in school systems.

Candidates for a master's degree must meet the requirements for admission to graduate study and, in addition, (1) must hold, or be eligible to hold, a valid teaching certificate (persons not meeting this criterion may work on overcoming deficiencies; graduate credit, but not degree credit, may be received



for graduate courses taken to overcome such deficiencies) and (2) must have had at least one year of teaching experience or the equivalent.

The master's program has been planned so that those completing the program will also meet the state requirements for "reading specialist" certification.

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

Detailed descriptions of courses available in reading may be found under Reading, Communication, and Language Education: RCLEd. 420, 440, 446, 450, 526, 540, 545, 550, 551, 557, 596, 597.

## EARTH SCIENCES (EARTH)

CHARLES THORNTON, *In Charge of Graduate Program in Earth Sciences*  
539 Deike Building  
814-865-4462

*Degrees Conferred:* D.Ed., M.Ed.

*Graduate Faculty:* Senior Members Blackadar, Cahir, Cuffey, Dachille, R. de Pena, Dutton, Hosler, Lavin, Lewis, Panofsky, Schmalz, Thomson, Thornton, Traverse, Wernstedt, Williams, and Wright.

*Graduate Faculty:* Associate Members Olivero and J. Pena.

The M.Ed. program is designed to meet the needs of science teachers in elementary and secondary schools. The earth science fields of study are geography, geological sciences (geology, geochemistry and mineralogy, or geophysics), and meteorology. The student selects one of the earth sciences as an area of concentration, takes at least 12 credits in it, and is required to write a paper in that area. An additional 12 credits must be taken in the other two fields of earth sciences; or 6 credits may be taken in one of the earth science fields plus 6 credits in other science or engineering fields. Two education courses, C.I. 400 and Sci.Ed. 558, are required as a minor.

Students with a 2.50 junior-senior average, 18 credits in education and related psychology, and 6 credits in earth science fields or other appropriate background will be considered for admission to the M.Ed. program. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests. The M.Ed. program is not offered during the summer term.

The D.Ed. program is designed for secondary school and college science teachers. The course requirements are planned by the candidate's committee. A minimum of 60 credits must include one area of concentration within the earth sciences — geography, geological sciences (geology, geochemistry and mineralogy, or geophysics), or meteorology — plus courses from each of the other two earth science areas. A minimum of 15 credits each is required in professional education and in thesis research. The thesis topic must be in one of the earth sciences. Three consecutive terms of residence are required for the D.Ed. degree. The student's D.Ed. committee shall normally consist of five members — two members from the area of concentration, one member from each of the other two earth science fields, and one member from education.

In order to enter the D.Ed. program a candidate should present evidence of competence at the baccalaureate level in one of the earth sciences (geography, geological sciences, or meteorology) or in an allied science curriculum. Students with a 2.70 junior-senior average and with appropriate course backgrounds will be considered for admission. Exceptions to the minimum 2.70 grade-point average will be made for students with special backgrounds, abilities, and interests.

## EARTH SCIENCES (EARTH)

- 400. EARTH SCIENCES SEMINAR (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

500. EARTH SCIENCES RESEARCH (1-6) Relationships between the earth sciences revealed by theory, analytical methods, or a selected problem.

## ECOLOGY (ECLGY)

EDWARD D. BELLIS, *In Charge of Graduate Programs in Ecology*  
311 Erwin W. Mueller Building  
814-865-3942

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Baker, Bellis, Cameron, Card, Cooper, Cuffey, Davis, DeWalle, Dunson, George, Graves, Guber, Hower, Hutnik, Keener, Kim, MacCluer, McDonnell, Patil, Pearson, Rothenbacher, Schein, Shipman, Sopper, Unz, and F. Williams.

*Graduate Faculty:* Associate Members Arnold, Burris, Kurland, and Stephenson.

This intercollege program emphasizes the properties of ecosystems by focusing attention on interactions of single organisms, populations, and communities with their environment. It is designed to give students a basic understanding of ecological theory and research techniques and is complementary to other environmental programs which emphasize man's role in ecosystems.

The instructional program includes three to five graduate core courses in ecology, augmented by an additional integrated group of seminars and courses selected for each student by the committee, and a research project directed by the thesis adviser. The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of one foreign language. The nonthesis option is available for the M.S. degree at the adviser's discretion.

The program is administered by a committee drawn from faculty members in several departments and colleges of the University. This committee and its chairman are appointed by the dean of the Graduate School. The instructional staff is composed of participating faculty in those departments offering graduate courses in fields closely allied to ecology.

The committee appointed by the Graduate School for each candidate in ecology is selected from members of the program committee and faculty from the student's area of specialization. The committee has the responsibility for determining the course program and research acceptable in satisfying degree requirements.

Students meeting the admission requirements of the Graduate School will be considered up to the number of spaces available in selecting candidates in this program. Candidates should have a strong science background including chemistry through organic chemistry, mathematics through calculus, physics, and biology. Students with a unique background in another discipline which has potential value to original ecological work will be seriously considered. A junior-senior grade-point average of 3.00 or better is required.

Students are strongly urged to choose their research interests and initiate communication with the relevant faculty member(s) before applying for admission. This is especially crucial if the student is seeking financial aid. Teaching and research assistantships are available only through the student's faculty adviser.

Formal applications along with Graduate Record Examination scores including verbal, quantitative, and an advanced test should be sent to the Graduate School. The applicant should forward the following *directly to the program chairman*: (1) two or more letters of recommendation regarding the student's academic and professional promise; and (2) a concise one-page statement describing the student's goals both within the program and in professional life. Specific inquiries about the ecology program may be directed to the program chairman.

Detailed descriptions of courses now available for students majoring in ecology may be found under the offerings of several ecologically oriented departments.

## ECOLOGY (ECLGY)

590. COLLOQUIUM (1-3)



## ECONOMICS (ECON)

MONROE NEWMAN, *Head of the Department*  
613 Kern Graduate Building  
814-865-1456

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Senior Members Budd, Farr, Feller, Herendeen, Hu, Klein, Lombra, Mehra, Nelson, Newman, Prybyla, Riew, Robinson, Rodgers, and Rozen.

*Graduate Faculty:* Associate Members Benson, Dickinson, Feinberg, Fox, Hartigan, Ott, Rosenberg, Stephenson, Wasylenko, Wentzler, and Witte.

Opportunities are available for concentration in the following fields: economic analysis, economic doctrines, economic development of developed areas, economic development of underdeveloped areas, economic fluctuations, income distribution, industrial organization, international economics, comparative economic systems, labor economics, money and banking, public finance, quantitative economics, statistics, and regional economics.

Students may also qualify for admission to the program in population issues, consisting of interdisciplinary course work with special emphasis on the economic, social, and geographic issues arising from the dynamics of population change.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by any of the following alternatives: (1) a reading knowledge of two foreign languages, (2) a reading knowledge of one foreign language and 6 credits of other course work from designated areas which increase research skills, (3) the equivalent of 12 credits of departmentally approved course work which increases research skills, or (4) a comprehensive knowledge of one foreign language. The nonthesis option is available for the M.A. degree; a student choosing the program option in operations research must complete a thesis.

To enter graduate work in economics a student should have completed at least 18 undergraduate credits in the fields of economics, accounting, commerce, and business statistics, including at least 6 credits in economics. All applicants must take the Graduate Record Examination in advanced economics and general aptitude.

Students with a 2.50 junior-senior average, a 3.00 average in courses in economics, and appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

Students in this program may elect the dual-title degree program option in operations research for the Ph.D. and M.A. degrees (see p. 249).

## ECONOMICS (ECON)

- 400. HISTORY OF ECONOMIC THOUGHT I (3)
- 401. HISTORY OF ECONOMIC THOUGHT II (3)
- 404. CURRENT ECONOMIC ISSUES (3)
- 405. SEMINAR IN ECONOMIC ANALYSIS (3)
- 412. LABOR MARKETS AND COLLECTIVE BARGAINING (3)
- 415. ECONOMICS OF INCOME MAINTENANCE (3)
- 423. STATE AND LOCAL TAXATION (3)
- 424. URBAN ECONOMICS (3)
- 425. ECONOMICS OF PUBLIC EXPENDITURES (3)
- 427. (Ed. Adm. 427) ECONOMICS OF EDUCATION (3)
- 428. ENVIRONMENTAL ECONOMICS (3)
- 429. ADVANCED PUBLIC FINANCE (3)
- 433. INTERNATIONAL MONETARY ECONOMICS (3)
- 442. MONOPOLY, COMPETITION, AND THEIR REGULATION (3)
- 445. (H.P.A. 445) HEALTH ECONOMICS (3)

450. THE BUSINESS CYCLE (3)
451. MONETARY THEORY AND POLICY (3)
463. ECONOMIC DEMOGRAPHY (3)
480. MATHEMATICAL ECONOMICS (3)
489. HONORS THESIS (3-6)
490. INTRODUCTION TO ECONOMETRICS (3)
496. INDEPENDENT STUDIES (1-12)
497. SPECIAL TOPICS (1-6)
499. FOREIGN STUDY — ECONOMICS (2-6)
  
500. ECONOMIC SEMINAR (3-6)
502. MICROECONOMIC ANALYSIS (3) Economic behavior under pure and imperfect competition; price and output determination in product markets; prices and employment in factor markets.
503. MACROECONOMIC ANALYSIS (3) National income accounts; determination of income, employment, interest rates, and the price level; stabilization policy.
506. PROBLEMS IN ECONOMICS (1-12) Planned projects involving library, laboratory, or field work.
507. INTERNATIONAL TRADE (3) A survey of international trade theory including modern developments of pure theory, and of international trade policy.
508. CURRENT MONETARY THEORY AND POLICY (3) Post-Keynesian reformulation of quantity and Keynesian theories of money; liquidity and general equilibrium approaches; current issues in theory and policy.
510. (Ag.Ec. 510) ECONOMETRICS I (3) General linear model, multicollinearity, specification error, autocorrelation, heteroskedasticity, restricted least squares, functional form, dummy variables, limited dependent variables. Prerequisite: Econ. 490 or Stat. 462 or 501.
511. (Ag.Ec. 511) ECONOMETRICS II (3) Stochastic regressors, distributed lag models, pooling cross-section and time-series data, simultaneous equation models. Prerequisite: Econ. 510.
513. DEVELOPMENT OF ECONOMIC DOCTRINES (3-6)
515. ECONOMICS OF THE LABOR MARKET (3) Theory and problems of labor-management relations; selected problems of the labor market with reference to current research and developments.
516. ECONOMICS OF HUMAN RESOURCES (3) Analysis of changes in human resource supply and demand; factors affecting these changes; current human resource policies.
517. INTERNATIONAL FINANCE (3) Problems of international liquidity; balance of payments adjustment; international financial institutions and selected policy problems.
518. DEVELOPMENT OF MONETARY THEORY (3) Classical and neoclassical quantity theories of money and contemporary criticism; Keynesian monetary theory and its critics.
519. (Mn.Ec. 519) MINERAL POLICY ANALYSIS (3) Principles of policy analysis; cost-benefit and other analytical techniques; environmental analyses; case studies of legislative and administrative mineral policy issues.
521. ADVANCED MICROECONOMIC THEORY (3-6) Theory of consumer behavior; theory of the firm; price determination in product and factor markets; introduction to welfare economics.
522. ADVANCED MACROECONOMIC THEORY (3-6) Measurement of income; theories of consumption, investment, and money holdings; static determination of income and employment; introduction to dynamic analysis.
524. INCOME DISTRIBUTION (3) Measurement of inequality; ethical issues in income redistribution; measurement and determination of distributive shares; problem of poverty.
525. ECONOMICS OF TECHNOLOGICAL CHANGE (3) Theoretical and empirical analysis of invention and innovation and their effects on productivity, employment, and market structure.
529. PUBLIC FINANCE (3-6) Contemporary problems in public finance; instruments of fiscal policy in the achievement of full employment, price stability, and economic development.



530. REGIONAL MICROECONOMICS (3) Location theory; analysis of market areas and spatial price behavior; urban systems; selected urban issues.
531. REGIONAL MACROECONOMICS (3) Analysis of levels of regional economic activity; migration; growth policies and strategies; evaluation.
543. INDUSTRIAL ORGANIZATION AND PUBLIC POLICY (3-6) The structure of American industry; performance and behavior; public policies toward business.
550. ECONOMIC FLUCTUATIONS (3) Analysis of the various theories of economic fluctuations; their methodological premises.
551. STABILIZATION POLICY (3) Description and analysis of the alternatives and issues in stabilization policy.
560. SEMINAR IN ECONOMIC GROWTH: UNDERDEVELOPED AREAS (3-6) Resources and institutions; quantitative measures; theories of economic growth in developing areas; developmental policies.
561. SEMINAR IN ECONOMIC GROWTH: DEVELOPED AREAS (3-6) Growth models; strategic factors in growth; quantification problems; public policy.
571. COMPARATIVE ECONOMIC SYSTEMS (3-6) Comparative analysis of alternative resource allocation principles; growth and performance of different economic systems; problems of decision making and control.
572. SOVIET AND OTHER CENTRALLY PLANNED ECONOMIES (3-6) Principles, structure, and performance of centrally planned economies with special emphasis on the Soviet Union.
580. MATHEMATICAL ECONOMICS (3-9) Mathematical development of static and dynamic economic models: partial and general equilibrium analysis; growth dynamics; mathematical programming. Prerequisite: Econ. 480.
595. (Ag.Ec. 595) SEMINAR IN ECONOMETRIC THEORY (3) Theories and methods relevant to the application of statistical methods to economics. Prerequisite: Econ. 510.
596. INDIVIDUAL STUDIES (1-6)
597. SPECIAL TOPICS (1-6)

## EDUCATIONAL ADMINISTRATION (EDADM)

PATRICK D. LYNCH, *In Charge of Graduate Programs in Educational Administration*  
318 Rackley Building  
814-865-1487

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Senior Members Boyd, Caldwell, Johnson, Lynch, and Willower.

*Graduate Faculty:* Associate Members Fraser, Noley, and Shemick.

Graduate work in educational administration is available to those who wish to exercise leadership roles in educational policy and management. Among those roles are principals, supervisors, and superintendents of public and independent schools, intermediate unit officials, state and federal agency administrators and staff, professors of educational administration, and research and development personnel.

All candidates for the M.Ed. and M.S. degrees will complete a minimum of 30 graduate credits. Certification for the principalship in Pennsylvania requires the completion of at least 45 graduate credits. An additional 25 hours are required for a superintendent's letter of eligibility. Certain state colleges in Pennsylvania offer work in cooperation with the University which leads to certification.

Candidates for the D.Ed. and Ph.D. degrees are required to spend three out of four terms in full-time residence during a twelve-month period. Ph.D. candidates are strongly encouraged to spend two academic years in residence. D.Ed. candidates may make application to satisfy the three terms of residence in another way consistent with Graduate School policy, if they can furnish satisfactory reasons for such a request.

Candidates for all degrees are required to combine work in the social sciences and humanities with the specialization in educational administration.

All applicants for any graduate program, including certification, must submit either a Miller Analogies Test or a Graduate Record Examination (quantitative and verbal) score. A 2.60 junior-senior undergraduate average is required of those desiring admission to a master's program. A grade-point average of 3.50 in prior graduate work is required of those who wish to enter a doctoral program. The best-qualified students will be accepted up to the number of spaces available for new students. Special backgrounds and experiences may allow for conditional admission of those not meeting stated criteria. Applicants for principalship certification in the state of Pennsylvania must hold teacher certification and experience.

More details concerning admission to and work in the degree and certification programs are presented in a program prospectus that is available upon request, as well as in the general information section of this bulletin. Students in the M.S. and Ph.D. programs in educational administration may elect the dual-title degree program option in operations research for the Ph.D. and M.S. degrees (see p. 249).

### EDUCATIONAL ADMINISTRATION (EDADM)

- 427. (Econ. 427) ECONOMICS OF EDUCATION (3)
- 460. (Hi.Ed. 460) INTRODUCTION TO ADULT EDUCATION (3)
- 480. EDUCATIONAL ADMINISTRATION (2-3)
- 481. COLLECTIVE NEGOTIATIONS IN PUBLIC EDUCATION (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 525. FEDERAL EDUCATION POLICIES (3) Analysis of federal role in development of educational policy and its relationship to state and local policy.
- 528. POLITICS AND EDUCATION (3) Social forces which shape the educational system and determine national, state, and local educational policies.
- 533. THE POLITICS OF LOCAL SCHOOL DISTRICTS (3) The methodology of studying political decision making and the theory and practice of politics in local school districts. Prerequisite: 6 credits of sociology, anthropology, or political science.
- 560. SYSTEM THEORY IN EDUCATION (3) Concepts of general system theory, the systems approach, and related methodologies and tools; applications in education; critique of instructional systems. Prerequisites: Ed.Psy. 400, 475.
- 565. PERSONNEL AND GRIEVANCE ADMINISTRATION (2-3) Practice and theory of personnel supervision at the central office and building level, including contract administration and grievance handling. Prerequisites: 18 credits in education and three years' teaching experience.
- 567. ORGANIZATIONAL SUPERVISION (3) The organizational context of the school, its relationship to supervision, and the improvement of instruction. Prerequisites: Ed.Adm. 480 and teaching experience.
- 568. THE PRINCIPALSHIP (2-3) For elementary and secondary principals. The administrative and management tasks of building administration. The social system, change, and community relationships.
- 569. PRINCIPALSHIP SEMINAR (2-3) The study and application of interdisciplinary-based products and processes in the various organizational units within the educational system.
- 571. THE EDUCATIONAL PLANT (2-3) School plant needs in terms of school population and curriculums; the building survey, developing a plant program, the building site, plant utilization, operation and maintenance, heating and ventilation, equipment, school building costs and finance. Prerequisite: Ed.Adm. 480 or teaching or administrative or supervisory experience.
- 573. PUBLIC SCHOOL FINANCE (2-3) Financing of public education in relation to organization and control; the conceptual basis for local financial administration; taxation, state and federal aid, school revenue, and money management. Prerequisite: Ed.Adm. 480 or teaching or administrative or supervisory experience.



574. **THEORY AND PRACTICE OF EDUCATIONAL NEGOTIATIONS (2-3)** Theoretical framework, bargaining strategies, legislation, administrative roles, agreements, etc. Prerequisites: Ed.Adm. 480 or teaching or administrative or supervisory experience, and previous work in school administration.
575. (Hi.Ed. 575) **ADMINISTRATION OF ADULT EDUCATION (3)** The organization of a program of adult education; its legal status, finances, selection of teachers, learning personnel, housing, and other administrative problems connected with adult education. Prerequisite: Ed.Adm. 480 or teaching or administrative or supervisory experience.
576. **LEGAL ASPECTS OF SCHOOL ADMINISTRATION (3)** Legal bases for the organization and administration of school districts and schools; the powers, rights, privileges, and responsibilities of school corporations, school boards, administrators, and personnel; the law and fiscal policies, the course of study, textbooks; contracts; taxes, torts; records; agents; and the judicial decisions involved. Prerequisite: Ed.Adm. 480 or teaching or administrative or supervisory experience.
577. **ECONOMIC DIMENSIONS OF EDUCATIONAL ADMINISTRATION (3)** Application of selected economic concepts and tools of analysis to administrative decision and planning processes in educational systems. Prerequisite: Ed.Adm. 480.
578. **SCHOOLS AS ORGANIZATIONS (2-3)** Intraorganizational relationships; administration and the school as a social system; formal and informal organization. Prerequisite: Ed.Adm. 480 or teaching or administrative or supervisory experience.
579. **PUBLIC SCHOOL BUSINESS ADMINISTRATION (2-3)** Business management applied to school management problems; budgeting, accounting, purchasing, insurance, school equipment, cafeteria management; transportation, salaries, personnel management, and auxiliary and coordinate agencies. Prerequisites: Ed.Adm. 480 or teaching or administrative or supervisory experience; Ed.Adm. 573.
580. **THE USE OF THEORY IN EDUCATIONAL ADMINISTRATION (1-6)** Administrative theories applied to educational organizations. Prerequisites: Ed.Adm. 480, 6 credits in educational administration.
581. **FIELD RESEARCH IN EDUCATIONAL ADMINISTRATION (2-3)** The use of field study methods in educational research and evaluation, and of participant observation in administration practice. Prerequisites: Ed.Adm. 480, 6 credits in educational administration.
582. **INTERNSHIP IN ADMINISTRATION AND SUPERVISION (1-12)** Internship to take place in schools or educational situations where student is not regularly employed, under supervision of graduate faculty.
583. **SUBSTANTIVE ISSUES IN SCHOOL LAW (3)** Focuses on substantive law in such areas as academic freedom, student records, teacher rights and responsibilities, and desegregation. Prerequisite: Ed.Adm. 576.
596. **INDIVIDUAL STUDIES (1-6)**
597. **SPECIAL TOPICS (1-6)**

## EDUCATIONAL PSYCHOLOGY (EDPSY)

JOSEPH FRENCH, *In Charge of Graduate Programs in Educational Psychology*  
403 Carpenter Building  
814-865-8303

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members DiVesta, French, Games, Marks, Mitzel, Rabinowitz, Roberts, Schwartz, Seibel, Thevaos, and Weener.

*Graduate Faculty:* Associate Member Snyder.

Graduate work is offered in the general field of educational psychology. Students may specialize and do research in school learning, educational and psychological measurement, statistics and research de-

sign as applied to education, and the evaluation of educational programs. There are two options in the master's program. A thesis option is available in any of the above areas, and the M.S. without thesis may be taken in learning or evaluation by teachers, counselors, administrators, parents, and others concerned with intervention strategies or evaluation of education programs. The M.S. with thesis is required for Ph.D. candidates. Other areas of study related to educational psychology, such as counseling and guidance, clinical psychology, school psychology, and special education, are offered in other departments of the University.

Doctoral degree requirements include a major emphasis in one of the above areas of educational psychology with minor emphasis in one other related area. The doctoral program of study includes a minimum of one course in each of the following areas: individual differences, psychological tests and measurement, statistics, experimental design, and learning from within the program; at least one course in developmental psychology, social psychology, and personality from the Department of Psychology; and at least one course in educational or philosophical foundations. In lieu of the foreign language requirement for the Ph.D. degree, students are expected to present to the committee a statement of objectives and goals and a plan of the academic and nonacademic work to be undertaken in achieving these goals. Within the context of the above, the students are expected to incorporate relevant experiences which are now part of the language and communication requirements, whether in course work, research, or teaching, to increase their effectiveness as educational psychologists.

Special facilities available to students include a research design laboratory, rooms for conducting research projects, and a closed-circuit television studio used for both research and instruction. Other facilities available to students majoring in educational psychology are the Nursery School, the Psychology Clinic, the Reading Center, the Center for Educational Diagnosis and Remediation, the Division of Instructional Services, and the Speech and Hearing Clinic. The Computation Center, with several computer systems, is available for use in graduate student research.

Students with a 3.00 junior-senior average and a broad undergraduate background including some college mathematics will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. Applicants are required to submit scores on the Graduate Record Examination. Applicants with a master's degree will be required to show more than minimum success in graduate study, including at least one-half of their graduate credits of A quality.

## EDUCATIONAL PSYCHOLOGY (EDPSY)

- 400. INTRODUCTION TO STATISTICS IN EDUCATIONAL RESEARCH (3)
- 406. APPLIED STATISTICAL INFERENCE FOR THE BEHAVIORAL SCIENCES (3)
- 421. LEARNING PROCESSES IN RELATION TO EDUCATIONAL PRACTICES (3)
- 450. (Psy. 450) PRINCIPLES OF MEASUREMENT (3)
- 451. APPRAISAL AND INTERPRETATION OF STANDARDIZED GROUP TESTS (2)
- 475. INTRODUCTION TO EDUCATIONAL RESEARCH (2)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 506. ADVANCED TECHNIQUES FOR ANALYZING EDUCATIONAL EXPERIMENTS (3) Analytical and experimental control considerations for designs involving nested and/or crossed subjects. Analysis of variance and multiple comparisons via computers. Prerequisite: Ed.Psy. 406 or Psy. 415.
- 507. MULTIVARIATE PROCEDURES IN EDUCATIONAL RESEARCH (3) Introduction to matrix algebra, computer programming, multiple regression analysis, multiple and canonical correlation, multiple discriminant analysis, classification procedures, factor analysis. Prerequisite: Ed.Psy. 406 or Psy. 415.
- 512. GROUP PROCESSES IN THE CLASSROOM (2) Basic concepts and perspectives in the study of group processes; instructional group interaction; analysis of classroom behavior.
- 513. INDIVIDUAL AND GROUP DIFFERENCES (2) Historical and contemporary attempts to relate individual differences to important social and educational issues. Prerequisite: Ed.Psy. 400 or Psy. 15.
- 518. CONTEMPORARY LEARNING MODELS IN EDUCATIONAL PSYCHOLOGY (3) Contemporary math-



emational models and computer simulations of complex human learning occurring in school settings. Modes for analyzing the learning environment. Prerequisite: Ed.Psy. 421.

519. PSYCHOLOGICAL FOUNDATIONS FOR COLLEGE TEACHING (2) Psychological, sociological, and organizational variables which influence college student behavior. Designed for graduate students who anticipate careers in college teaching.

522. CONCEPT LEARNING IN THE SCHOOLS (2) Study of theory and research related to concept formation and attainment with implications for instruction. Prerequisite: Ed.Psy. 421.

523. PROBLEM SOLVING IN THE SCHOOLS (2) Examination of theory and research related to cognitive processes in problem solving with implications for educational practice. Prerequisite: Ed.Psy. 421.

524. THEORIES OF LEARNING AND INSTRUCTION (3) Study of major classical theories of learning and recent developments in learning and instructional theory. Prerequisite: Ed.Psy. 421.

526. (RCLEd. 526) THE PSYCHOLOGY OF READING (3) Psychological principles underlying the process of reading and comprehending with application to instruction. Prerequisite: Ed.Psy. 421.

527. PSYCHOLOGY OF ADULTS AS LEARNERS (3) Psychological principles related to learning by adults, with application to instruction and other educational practices. Prerequisite: Ed.Psy. 421.

550. DESIGN AND CONSTRUCTION OF PSYCHOLOGICAL MEASURES (3) Lecture-practicum involving planning, construction, administration, and analysis of a psychological test; lectures stress construct validity, item analysis, and predictive validity. Prerequisite: Ed.Psy. 450.

554. THEORIES OF PSYCHOLOGICAL MEASUREMENT (2) Basic true-score and error models; their extensions to test reliability and test validity; problems of item analysis and weighting. Prerequisite: Ed.Psy. 450.

575. SEMINAR IN EDUCATIONAL PSYCHOLOGY (3-9) A seminar dealing with specific topics in educational psychology. Open to advanced students in the behavioral sciences.

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## EDUCATIONAL THEORY AND POLICY (EDTHP)

JOHN HARDIN BEST, *In Charge of Graduate Programs in Educational Theory and Policy*  
320 Rackley Building  
814-865-1488

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Senior Members Alessandro, Best, H. Johnson, and Takei.

*Graduate Faculty:* Associate Members Lindsay, McKenna, and Noley.

The master's and doctoral programs in educational theory and policy are designed to prepare persons for careers in education policy development and analysis. Individual multidisciplinary programs of study in the cultural foundations of education and in the social sciences, management sciences, and/or humanities will be designed jointly by the student and the program faculty.

Candidates who seek a M.A. in educational theory and policy shall complete programs embracing a minimum of 33 graduate credits including a minimum of 9 graduate credits in areas of social theory, policy, and planning or in the social sciences or humanities. Candidates who seek a Ph.D. in educational theory and policy will complete programs embracing a minimum of 75 graduate credits including a minimum of 24 graduate credits in areas of social theory, policy, and planning or in the social sciences or humanities.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by options selected from foreign languages, statistics or mathematics, or computer science.

Candidates for the Ph.D. degree are required to complete a minimum of three consecutive terms during a calendar year in residence.

The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Students with a 2.75 grade-point average will be considered for admission to a master's program, and a 3.50 grade-point average for the Ph.D. program. Exceptions to the minimum grade-point average may be made for students with special backgrounds, abilities, and interests.

### EDUCATIONAL THEORY AND POLICY (EDTHP)

- 401. INTRODUCTION TO COMPARATIVE EDUCATION (3)
- 404. EDUCATION IN AFRICA (3)
- 411. ETHNIC MINORITIES AND SCHOOLS IN THE UNITED STATES (3)
- 415. (Anthy. 415) ANTHROPOLOGY OF EDUCATION (3)
- 416. (Soc. 416) SOCIOLOGY OF EDUCATION (3)
- 430. HISTORY OF EDUCATION IN THE UNITED STATES (2-3)
- 440. INTRODUCTION TO PHILOSOPHY OF EDUCATION (3)
  
- 501. EDUCATION IN DEVELOPING COUNTRIES (3) The meaning of development and the role of education in the development process: theories, agents, trends, and case studies.
- 514. SOCIAL CHANGE, CULTURAL DYNAMICS, AND EDUCATION (3) The role of the school in promoting either social change or stability.
  
- 536. STUDIES IN EDUCATIONAL THOUGHT (3) Studies in the historical development of educational theory.
- 540. DEWEY AND THE PRAGMATIC-INSTRUMENTALIST EDUCATIONAL TRADITION (3) Critical examination of John Dewey's educational thought in the context of pragmatic philosophy and progressivism in American education.
- 541. CONTEMPORARY PHILOSOPHIES OF EDUCATION (3) Educational theory and practice in relation to contemporary movements in philosophy.
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)

## ELECTRICAL ENGINEERING (E E)

DALE M. GRIMES, *Head of the Department*  
 118 Electrical Engineering East  
 814-865-7667

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Adams, Brown, Carpenter, Cross, Das, Etzweiler, Ferraro, Geselowitz, Grimes, Hale, Lachs, Lee, Lewis, McMurtry, Mentzer, Nisbet, Robinson, Ross, Stach, Trutt, and Yu.

*Graduate Faculty:* Associate Members Coraor, Delansky, Fonash, Herman, Hulina, Kerr, Mathews, Mitchell, Mollo, Monkowski, Roytman, and Symons.

The principal areas of graduate research are in ionospheric studies, solid state electronics, computers and digital systems, power systems, and electromagnetics. Course offerings support these research areas, as well as work in automatic control, biomedical engineering, communications, network and system theory, plasmas, and quantum electronics.

For information about areas of specialization, laboratory and research facilities, fellowships, assistantships, and other sources of financial assistance, write directly to the Department of Electrical Engineering, The Pennsylvania State University, University Park, PA 16802.



The Master of Science requirements include the general requirements of the Graduate School as listed under Master's Degrees. Specific departmental requirements are the following:

Admission: (a) Satisfactory completion of an undergraduate electrical engineering program at an accredited institution or the equivalent, or (b) satisfactory completion of an undergraduate physics program at The Pennsylvania State University or an equivalent institution, with a minor in electronics. This program requires the participant to take two undergraduate courses in addition to the specific course requirements listed below. There are also some restrictions on the electives taken within this program.

Specific Course Requirements: (a) Thesis option — 24 course credits, 6 thesis credits, and a satisfactory thesis; (b) Nonthesis option — 30 course credits, a scholarly report, and a special M.S. exam.

The Doctor of Philosophy requirements include the general requirements of the Graduate School as listed under Doctoral Degrees.

Admission: (a) Satisfactory completion of the M.S. degree requirements in electrical engineering or a closely related field at The Pennsylvania State University or an equivalent institution, or (b) direct admission from the undergraduate program with appropriate undergraduate standing.

Specific Requirements: The communication requirement is met by adequacy in the English language and computer programming. The candidacy exam consists of both written and oral parts and is the same as the M.S. examination used at The Pennsylvania State University. The comprehensive exam is oral.

Students in this program may elect the dual-title program option in operations research for the Ph.D. and M.S. degrees (see p. 249).

## ELECTRICAL ENGINEERING (E E)

- 405. ELECTRONIC INSTRUMENTATION FOR NONELECTRICAL ENGINEERS AND SCIENTISTS (3)
- 406. ELECTRICAL POWER GENERATION AND TRANSMISSION (3)
- 411. PRINCIPLES OF ELECTROMAGNETIC FIELDS (3)
- 413. LINEAR NETWORK ANALYSIS (3)
- 414. PRINCIPLES AND APPLICATIONS OF LASERS AND MASERS (3)
- 415. (Cmp.Sc. 415) COMPUTER SYSTEMS ARCHITECTURE (3)
- 417. SYSTEM THEORY (3)
- 418. SOLID STATE DEVICE TECHNOLOGY (3)
- 419. SOLID STATE DEVICES (3)
- 423. FUNDAMENTALS OF INDUSTRIAL ELECTRONICS (3)
- 424. FUNDAMENTALS OF ELECTRICAL DESIGN (3)
- 425. SYMMETRICAL COMPONENTS (3)
- 427. DISCRETE-TIME SYSTEMS (3)
- 428. LINEAR CONTROL SYSTEMS (3)
- 432. UHF AND MICROWAVE ENGINEERING (3)
- 438. ANTENNA ENGINEERING (3)
- 441. ACTIVE CIRCUITS (3)
- 448. LINEAR ELECTRONIC DESIGN (3)
- 449. DIGITAL ELECTRONIC DESIGN (3)
- 450. NETWORK ANALYSIS (3)
- 458. DATA COMMUNICATION (3)
- 459. INTRODUCTION TO STATISTICAL THEORY OF COMMUNICATIONS (3)
- 461. FUNDAMENTALS OF POWER SYSTEM STABILITY (3)
- 470. ELECTRONIC ANALOG COMPUTERS (3)
- 472. DIGITAL SYSTEMS (3)
- 473. DIGITAL SYSTEMS LABORATORY (3)
- 475. INTRODUCTION TO HYBRID COMPUTATION (3)
- 477. SYNTHESIS AND DESIGN OF ELECTRICAL SYSTEMS (3)
- 490. (Nuc.E. 490) INTRODUCTION TO PLASMAS (3)
- 492. (Astro. 492) SPACE ASTRONOMY AND INTRODUCTION TO SPACE SCIENCE (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

519. SEMICONDUCTOR DEVICES (3) Characteristics and limitations of bipolar transistors, diodes, transit time and bulk-effect devices. Prerequisite: E.E. 419.
521. ADVANCED ELECTRICAL ENGINEERING PROBLEMS (1-10)
527. LINEAR CONTROL SYSTEMS (3) Continuous and discrete-time linear control systems; state variable models; analytical design for deterministic and random inputs; time-varying systems stability. Prerequisites: E.E. 428 or M.E. 455; E.E. 417.
528. NONLINEAR CONTROL AND STABILITY (3) Design of nonlinear automatic control systems; phase-plane methods; describing functions; optimum switched systems; Liapunov stability; special topics in stability. Prerequisites: E.E. 428 or M.E. 455; E.E. 417.
529. OPTIMAL CONTROL (3) Variational methods in control system design; classical calculus of variations, dynamic programming, maximum principle; optimal digital control systems; state estimation. Prerequisite: E.E. 527.
530. ADAPTIVE AND LEARNING SYSTEMS (3) Adaptive and learning control systems; system identification; performance indices; gradient, stochastic approximation, controlled random search methods; introduction to pattern recognition. Prerequisite: E.E. 527.
535. ENGINEERING ANALYSIS (3) Applications of mapping methods, series and integral representations to the solution of boundary value problems in electrical engineering.
540. (Nuc.E. 540) THEORY OF PLASMA WAVES (3) Solutions of the Boltzmann equation; waves in bounded and unbounded plasmas; radiation and scattering from plasmas. Prerequisite: E.E. 490.
541. (Nuc.E. 541) PLASMA THEORY (3) Advanced topics in kinetic theory, fluctuation theory, microinstability, and turbulence. Prerequisite: E.E. 540 (Nuc.E. 540).
546. FIELD-EFFECT DEVICES (3) The physical background, characteristics, and limitations of surface field-effect and junction field-effect devices and related structures. Prerequisite: E.E. 419.
547. DIELECTRIC DEVICES (3) Applications of insulator physics and devices based on insulator properties. Prerequisite: E.E. 419.
548. LINEAR INTEGRATED CIRCUITS (3) Design of monolithic, thin-film, and hybrid linear integrated circuits; D.C., video, tuned, r.f., and microwave applications. Emphasis on reliability. Prerequisites: E.E. 418, 448.
550. NETWORK SYNTHESIS (3) Positive real functions, realizability conditions, synthesis of driving point immittances, synthesis of two-terminal pair networks, transfer function synthesis. Prerequisite: E.E. 450.
560. STATISTICAL THEORY OF COMMUNICATIONS (3) Generalized harmonic analysis; the application of correlation and convolution to the detection of signals in noise; various special topics. Prerequisite: E.E. 459 or Math. 409.
561. INFORMATION THEORY (3) Mathematical measurement of information; information transfer in discrete systems; redundancy, efficiency, and channel capacity; encoding systems. Prerequisite: E.E. 459 or Math. 409.
562. DETECTION THEORY (3) Detection decision theory, Bayes and Neyman-Pearson criteria, optimal receivers, classical estimation theory, signal-noise representations, optimum linear signal parameters estimation. Prerequisite: E.E. 560.
565. COMPUTER ANALYSIS OF POWER SYSTEMS (3) Network matrix methods of power system analysis. Formulation and computer solution of short circuit, load flow, and transient stability problems. Prerequisites: Cmp.Sc. 201; E.E. 425 or 461.
569. SIMULATION OF BIOMEDICAL SYSTEMS (3) Simulation of biological and medical systems on analog and digital computers; direct electrical analogs; modeling techniques. Prerequisites: E.E. 470, Biol. 111.
570. ADVANCED ELECTRONIC ANALOG COMPUTERS (3) Advanced techniques of analog computation and simulation; machine and problem errors; nonlinear differential equations. Prerequisite: E.E. 470.



571. SWITCHING AND SEQUENTIAL MACHINE THEORY (4) Advanced treatment of switching and machine theory, minimization of machines, state assignment, hazard analysis. Prerequisite: E.E. 472.
572. DIGITAL SYSTEM DESIGN (3) Complete digital system design including specification, internal organization, and realization. Discussion of interaction among digital systems and subsystems. Prerequisite: E.E. 472.
573. FAULT DETECTION IN DIGITAL CIRCUITS (3) Advanced treatment of fault detection, location, and redundancy techniques. Prerequisite: E.E. 472.
580. RADIO WAVES AND THE IONOSPHERE (3) The magneto-ionic theory of ionospheric wave propagation; ray-optical approximations; determination of ionization profiles; full wave solutions; non-linear and coupling effects. Prerequisite: E.E. 62 or 438 or Phys. 557.
581. CONSTITUTION OF THE IONOSPHERE (3) Properties of neutral and ionized atmosphere above 60 km; photochemical processes; solar, meteoric perturbations of the ionosphere; large-scale movements in ionization.

## ENGINEERING MECHANICS (E MCH)

JOHN R. MENTZER, *Head of the Department of Engineering Science and Mechanics*  
227B Hammond Building  
814-865-6661

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Senior Members Conway, Fenlon, Fonash, Hayek, Hu, Kiusalaas, Llorens, Mentzer, Neubert, Queeney, Sharma, Thompson, and Zamrik.

*Graduate Faculty:* Associate Members Ashok and Pytel.

Graduate programs in engineering mechanics emphasize fundamental knowledge and include research opportunities in theoretical and experimental mechanics, with a primary focus on the mechanics and physics of solids.

Graduate study is available in continuum mechanics, structural mechanics, dynamics, vibrations and acoustics, biomechanics, micromechanics, experimental mechanics, and properties of materials. Thesis work in these areas is frequently directed toward specific applications of technological interest in biosystems, geosystems, energy production and distribution, materials engineering, and structural design.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of one foreign language.

Programs leading to a minor in engineering mechanics are available for doctoral students who seek to complement their studies in their major fields by acquiring a broader background in theoretical and experimental mechanics.

The entering student must hold a bachelor's degree in engineering or science and have satisfactorily completed undergraduate courses in mechanics. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

Other course offerings of the department are listed under *Other Graduate Courses*.

## ENGINEERING MECHANICS (E MCH)

400. ADVANCED STRENGTH OF MATERIALS AND DESIGN (3) *Hu*
401. DESIGN AND SYNTHESIS IN VIBRATIONS (3) *Hayek*
402. APPLIED AND EXPERIMENTAL STRESS ANALYSIS (3) *Conway*
403. STRENGTH DESIGN IN MATERIALS AND STRUCTURES (4) *Queeney*
407. COMPUTER METHODS IN ENGINEERING DESIGN (3) *Kiusalaas*
408. ELASTICITY AND ENGINEERING APPLICATIONS (3) *Kiusalaas*

- 409. ADVANCED MECHANICS (3) *Pytel*
- 410. MECHANICS OF SPACE FLIGHT (3) *Pytel*
- 412. EXPERIMENTAL METHODS IN VIBRATIONS (3) *Neubert*
- 415. FRACTURE MECHANICS (3) *Queeney*
- 446. MECHANICS OF VISCOELASTIC MATERIALS (3) *Sharma*
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

500. ADVANCED MECHANICS OF MATERIALS (3-6) Strain energy methods; special problems in bending and torsion; curved bars, beams on elastic foundations; thick-walled cylinders, shrink-fit assemblies, and rotating discs; thin-walled pressure vessels; bending of thin plates; buckling of bars and plates. Prerequisite: E.Mch. 13. *Zamrik*

506. EXPERIMENTAL STRESS ANALYSIS (3) Experimental methods of stress determination including photoelasticity, stress coat and electric strain gauge techniques; stress analogies; strain rosettes for combined stress determinations. Prerequisite: E.Mch. 408 or 507. *Conway*

507. THEORY OF ELASTICITY AND APPLICATIONS (3) Equations of equilibrium and compatibility; stresses and strains in beams, curved members, rotating discs, thick cylinders, torsion and structural members. Prerequisite: E.Mch. 13.

509. THEORY OF PLATES AND SHELLS (3) Bending and buckling of plates; elastic foundations; deformation of shells, multilayer shells, stress and stability analysis, weight optimization, application problems. Prerequisite: E.Mch. 13.

514. ENGINEERING MECHANICS SEMINAR (1 per term) Current literature and special problems in engineering mechanics.

516. MATHEMATICAL THEORY OF ELASTICITY (3) Fundamental equations and problems of elasticity theory; uniqueness theorems and variational principles; methods of stress functions and displacement potential; applications. Prerequisite: E.Mch. 540. *Hayek*

520. ADVANCED DYNAMICS (3) Dynamics of a particle and of rigid bodies; Newtonian equations in moving coordinate systems; Lagrange's and Hamilton's equations of motion; special problems in vibrations and dynamics. Prerequisites: E.Mch. 12, Math. 431. *Pytel*

521. STRESS WAVES IN SOLIDS (3) Theoretical fundamentals, classic experiments; recent advances, including scabbing applications, plastic waves, penetration mechanics, impact and numerical methods. Prerequisites: E.Mch. 12; Math. 432 or E.Mch. 524A and 524B.

522. THEORY OF VIBRATIONS (3) Mathematical theory of vibrating systems; damping phenomena; forced vibrations; analogy between mechanical and electrical vibrations; transverse and torsional oscillation of shafts; vibration of strings, beams, membranes, and plates. Prerequisites: E.Mch. 13, Math. 431. *Neubert*

524. MATHEMATICAL METHODS IN ENGINEERING (3 per unit) *Hayek and Thompson*

*Unit A* (3) Basic tools, including Fourier, Legendre, and other orthogonal series, special functions, Laplace transforms. Applications in mechanics and other fields. Prerequisite: Math. 351.

*Unit B* (3) Solution techniques for boundary-value problems in curvilinear coordinates, integral transforms. Green's functions, potentials, applications to diffusion, vibration, wave-propagation. Prerequisite: E.Mch. 524A or Math. 431.

525. VIBRATION AND SHOCK IN DAMPED MECHANICAL SYSTEMS (3) Rubberlike materials; vibration isolation; structural impedance; wave propagation; multiforce excitation of beams; Timoshenko beams; transients; shock spectra; damage; nonlinear response. Prerequisite: E.Mch. 401 or 522.

527. STRUCTURAL DYNAMICS (3) Dynamic behavior of structural systems; normal modes; input spectra; finite element representation of frameworks, plates, and shells; impedance; elastic-plastic response. Prerequisites: E.Mch. 12, 13. *Neubert*

528. EXPERIMENTAL METHODS IN VIBRATIONS (3) Investigation of one or more degrees of freedom, free and forced mechanical vibrations, vibration properties of materials, nondestructive testing. Prerequisite: E.Mch. 401 or 522. *Neubert*



530. SOLID STATE MECHANICS (3) Relation between solid state physics and mechanics; mechanical properties for static, fatigue, creep, and impact conditions; high-temperature properties; applications. *Hu*

531. THEORY OF PLASTICITY AND APPLICATIONS (3) Yield condition; plastic stress-strain relations; theory of slip-line fields; applications to bending, torsion, axially symmetric bodies, metal processing. Prerequisite: E.Mch. 507. *Hu*

535. (Metal. 535) CRYSTAL DEFECTS AND MECHANICAL RESPONSE (3) Mechanical responses of crystalline solids containing point, line, and interfacial defects; elastic and plastic responses. Prerequisite: Metal. 514 or E.Sc. 414. *Queeney*

540. INTRODUCTION TO CONTINUUM MECHANICS (3) Algebra and analysis of tensors; balance equations of classical physics; the linear theories of continuum mechanics. *Hayek*

546. THEORY OF VISCOELASTICITY AND APPLICATIONS (3) Linear and nonlinear viscoelastic theories; generalized isotropic and anisotropic viscoelastic stress-strain relations. Prerequisite: E.Mch. 507. *Sharma*

560. FINITE ELEMENT ANALYSIS (3) General theory; application to statics and dynamics of solids, structures, fluids, and heat flow; use of existing computer codes. Prerequisites: Cmp.Sc. 201, E.Mch. 13.

570. RANDOM VIBRATIONS IN STRUCTURAL MECHANICS (3) Probability theory applied to random vibrations of linear and nonlinear systems; excitation by ground motion, turbulence, and noise; acoustic damping. Prerequisite: Aersp. 411 or E.Mch. 401 or 522. *Neubert*

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

## ENGINEERING SCIENCE (E SC)

JOHN R. MENTZER, *Head of the Department of Engineering Science and Mechanics*  
227B Hammond Building  
814-865-6661

*Degree Conferred: M.S.*

*Graduate Faculty:* Senior Members Conway, Fenlon, Fonash, Hayek, Hu, Kiusalaas, Llorens, Mentzer, Neubert, Queeney, Sharma, Thompson, and Zamrik.

*Graduate Faculty:* Associate Members Ashok and Pytel.

This program is characterized by strong components in engineering analysis, the basic sciences, and areas of emerging technological importance. The program is interdisciplinary in structure with sufficient flexibility to allow a student to specialize in any of a variety of disciplines according to his or her professional objectives. The basic requirements of course work by subject area are as follows:

Engineering Analysis	— 6 credits
Materials	— 6 credits
Basic Sciences	— 6 credits
Engineering Sciences	— 6 credits

Within these guidelines, work in the listed areas may be arranged in consultation with the adviser to constitute a program of study to accommodate the objectives of the student, and it is expected that courses outside the department may constitute part of the content in the engineering sciences.

A thesis is required for the M.S. degree as part of the 30 credits required in the program.

Admission to the program requires a bachelor's degree in engineering or science from an accredited institution, with a junior-senior grade-point average of at least 2.50. The best-qualified applicants will be accepted up to the number of spaces that are available for new students.

This program should be distinguished from the graduate program in engineering science at Behrend, Capitol, and Radnor which offers the M.Eng. degree.

**ENGINEERING SCIENCE (E SC)**

- 400. ELECTROMAGNETIC FIELDS (3)
- 401. SENIOR DESIGN PROJECT (2)
- 402. SENIOR DESIGN PROJECT (2)
- 403. SENIOR DESIGN PROJECT (3)
- 404. ANALYSIS IN ENGINEERING SCIENCE (3)
- 405. ENGINEERING APPLICATIONS OF FIELD THEORY (3)
- 414. ELEMENTS OF MATERIAL SCIENCE (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

501. SOLID STATE ENERGY CONVERSION (3) Principles of solid state energy conversion and their utilization in engineering devices. Emphasis on current research and development efforts. Prerequisite: E.E. 419 or Phys. 412.

502. SEMICONDUCTOR HETEROJUNCTIONS AND APPLICATIONS (3) Theory, fabrication techniques, and electronic applications of semiconductor heterojunctions, including metal-semiconductor and electrolyte-semiconductor junctions. Prerequisite: E.Sc. 314 or 414.

511. ENGINEERING MATERIALS FOR ENERGY CONVERSION AND STORAGE (3) This course treats engineering materials and systems employed in conventional and unconventional direct energy conversion and energy storage.

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

NOTE: *Other departmental courses are listed under Engineering Mechanics.*

**ENGINEERING SCIENCE (E SC)**

MATTHEW ROSENSHINE, *Chairman of the Engineering Graduate Committee for Off-Campus Programs*  
207 Hammond Building  
814-863-2356

*Degree Conferred:* M.Eng.

Behrend College — Richard C. Bollinger, *Director of Program*

*Graduate Faculty:* Associate Members Bollinger and Salvia.

Radnor Center for Graduate Studies — Helmut E. Weber, *Director of Program*

*Graduate Faculty:* Senior Members Llorens and Weber.

*Graduate Faculty:* Associate Members Duncan, Kozik, and Stein.

Capitol Campus — John S. Wade, Jr., *Director of Program*

*Graduate Faculty:* Senior Members Bissinger, Cole, Dahir, Grenier, and Murty.

*Graduate Faculty:* Associate Members Ezard, Hartzler, Maynard, W. Miller, Przybylski, Rao, Schiller, Shoup, Wade, and Welsh.

A program leading to the degree of Master of Engineering with a major in engineering science is offered at Behrend College, the Radnor Center for Graduate Studies, and at the Capitol Campus, near Harrisburg. Details of the program may be obtained by writing directly to these locations. Addresses are given in the front of this catalog.

The program is designed to provide a broad, advanced education in the engineering sciences with some specialization permitted in the area of the student's major interest. It is offered specifically to permit practicing engineers to pursue advanced studies through evening classes while in full-time employ-



ment in industry in the area. Courses offered for the program are all established and controlled by the resident departments at the University Park Campus.

This program should be distinguished from the graduate program in engineering science at University Park which offers the M.S. degree.

The credit requirements in this major will be satisfied by an appropriate combination of core courses and elective courses. The core courses include offerings in mathematics and in several branches of engineering which have been selected because of their general character and breadth of applicability to all fields of engineering.

A minimum of 30 credits is required, of which at least 12 must be at the 500 level. A scholarly written report is also required. Three of the above credits may be applied to this report.

Students may be admitted to the program from a wide variety of disciplines. Students applying for admission are expected to have completed the following core of courses: (1) physics through modern physics, (2) mathematics through differential equations, (3) one course in engineering thermodynamics, (4) one course in electrical circuits, and (5) basic courses in engineering statics and dynamics. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

Further details regarding admission requirements are available from the directors of the graduate centers offering the program.

## ENGLISH (ENGL)

WENDELL V. HARRIS, *Head of the Department*  
117 Burrowes Building  
814-865-6381

*Degrees Conferred:* Ph.D., M.A., M.Ed.

*Graduate Faculty:* Senior Members Arnold, Austin, Balaban, Begnal, Borklund, Condee, Crane, Damerst, Downs, Harris, Hudspeth, R. Hume, Joukovsky, Kiernan, Lewis, Lougy, Mann, Meserole, O'Donnell, Price, Rodgers, Rogers, Secor, Smith, Trautmann, Walden, S. Weintraub, West, and Young.

*Graduate Faculty:* Associate Members Buck, Buckalew, Burns, Ebbitt, Eckhardt, Fitzgerald, Gidez, Grecco, K. Hume, Kiffer, McAdams, Moore, Rambeau, Schneeman, Thigpen, and Toth.

Candidates for the M.A. in English may specialize in English or American literature, or in writing. M.A. students take at least 33 credits, 6 of which can be earned by writing a thesis; they must also show reading proficiency in one foreign language and pass a master's examination. For admission, M.A. students specializing in literature should have strong backgrounds in English courses: 18 credits beyond freshman composition are a minimum, but the department prefers at least 24 credits. M.A. students specializing in writing concentrate in poetry, fiction, nonfiction, editing, or business and technical writing. Applicants should have backgrounds and abilities appropriate for their proposed courses of study. Writing students complete their degrees by submitting a body of original work or by submitting a thesis, which may in part grow out of the department's internship program.

To be considered for the doctoral program, students must have completed an M.A. in English or its equivalent. The records of potential students should indicate promise of superior work in doctoral study. The Ph.D. degree does not require a specific number of credits. With the help of departmental graduate advisers, students select a program of small seminars or reading courses. To complete their programs, students must show reading proficiency in two foreign languages, pass written comprehensive examinations, and write and defend a doctoral dissertation.

Applicants should have a junior-senior average of 3.20, although exceptions may be made for students with special backgrounds, abilities, and interests. Graduate Record Examination scores are required of all applicants. The best-qualified applicants will be accepted up to the number of spaces available for new students.

## ENGLISH (ENGL)

407. HISTORY OF THE ENGLISH LANGUAGE (3)
  408. APPLIED ENGLISH LANGUAGE ANALYSIS (3)
  410. RHETORICAL THEORY AND PRACTICE (3)
  411. PROBLEMS OF STYLE (3)
  412. THE WRITING OF FICTION (3-6)
  413. VERSE WRITING (3-6)
  414. BIOGRAPHICAL WRITING (3)
  415. NONFICTION WRITING (3 per term, maximum of 6)
  416. (Journ. 416) SCIENCE WRITING (3-6)
  417. THE EDITORIAL PROCESS (3)
  418. ADVANCED TECHNICAL WRITING AND EDITING (3-6)
  432. THE AMERICAN NOVEL TO 1900 (3)
  433. THE AMERICAN NOVEL: 1900-1945 (3)
  435. THE AMERICAN SHORT STORY (3)
  436. AMERICAN FICTION SINCE 1945 (3)
  437. THE POET IN AMERICA (3)
  438. AMERICAN DRAMA (3)
  439. AMERICAN NONFICTION PROSE (3)
  441. CHAUCER (3)
  443. THE ENGLISH RENAISSANCE (3)
  444. SHAKESPEARE (3)
  445. SHAKESPEARE'S CONTEMPORARIES (3)
  446. MILTON (3)
  451. THE RESTORATION AND THE EIGHTEENTH CENTURY (3)
  455. THE ENGLISH NOVEL TO JANE AUSTEN (3)
  460. THE ROMANTICS (3)
  464. THE VICTORIANS (3)
  465. VICTORIAN NOVEL (3)
  470. LITERATURE OF THE BRITISH COMMONWEALTH (3)
  475. MODERN BRITISH FICTION (3)
  477. MODERN POETRY (3)
  478. BRITISH AND IRISH DRAMA SINCE 1890 (3)
  484. (L.A. 484) COMPUTATIONAL AND QUANTITATIVE STYLISTICS (3)
  488. (C.Lit. 488) MODERN CONTINENTAL DRAMA (3)
  491. LITERATURE FOR TEACHERS IN SECONDARY SCHOOLS (3)
  492. HISTORY OF ENGLISH LITERARY CRITICISM (3)
  493. THE FOLKTALE IN AMERICAN LITERATURE (3)
  494. WOMEN WRITERS AND THEIR WORLDS (3)
  495. INTERNSHIP (3-6)
  496. INDEPENDENT STUDIES (1-12)
  497. SPECIAL TOPICS (1-6)
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501. MATERIALS AND METHODS OF RESEARCH (4) Materials and techniques of research in English and American literary history; form and content of theses. Required of all graduate students with an English major.
  502. THEORY AND TEACHING OF COMPOSITION (3) Study of grammar, logic, rhetoric, and style in their applicability to teaching composition.
  506. THE ENGLISH LANGUAGE (3) A problem-centered approach to literary and oral forms of English, utilizing historical and analytic perspectives.
  512. THE WRITING OF FICTION (3-6) Supervised workshop in advanced techniques of writing fiction.
  513. THE WRITING OF POETRY (3-6) For the student with considerable experience in writing poetry; a workshop devoted to advanced poetic technique.



515. THE WRITING OF NONFICTION (3-6) Supervised workshop in advanced nonfiction techniques.
520. THE MIDDLE ENGLISH ROMANCE (3) A detailed study of the Middle English metrical romance in terms of its milieu and its genre in the West.
521. OLD ENGLISH LANGUAGE (3) An introduction to the main features of the Old English language; readings in simple Old English prose and poetry.
522. BEOWULF (3) Reading and critical analysis. Prerequisite: Engl. 521.
523. WORDSWORTH AND COLERIDGE (3) Major and some minor works; the pertinent criticism and scholarship; aspects of the period.
524. BYRON AND SHELLEY (3) Major and some minor works; the pertinent criticism and scholarship; aspects of the period.
525. BLAKE AND KEATS (3) Major and some minor works; the pertinent criticism and scholarship; aspects of the period.
526. TENNYSON AND BROWNING (3)
536. HENRY JAMES (3) The development of James as critic, novelist, and short story writer.
540. STUDIES IN ELIZABETHAN PROSE AND POETRY (3-6)
541. MEDIEVAL STUDIES (3-6) Special problems in medieval English literature.
542. MIDDLE ENGLISH LITERATURE (3) Introduction to Middle English and its dialects; study of the literature of the period exclusive of Chaucer.
543. STUDIES IN EARLY SEVENTEENTH-CENTURY LITERATURE (3-6) Major poets and prose writers from 1600 to 1660.
544. RESTORATION LITERATURE (3) Selected studies of writers in England between 1650 and 1700.
545. CHAUCER (3-6) Critical study of the *Canterbury Tales* or *Troilus and Criseyde* and minor poems.
546. MILTON (3) The poetry and prose of John Milton.
548. ELIZABETHAN AND JACOBEAN DRAMA (3-6) English drama from 1558 to 1642, exclusive of Shakespeare.
549. SHAKESPEARE (3-6) Special problems of sources, chronology, text, characterization, and motivation in the drama.
552. SWIFT AND POPE (3)
553. THE AGE OF JOHNSON (3) The work of Johnson and his circle.
554. STUDIES IN EARLY AMERICAN LITERATURE (3)
556. EIGHTEENTH-CENTURY BRITISH FICTION (3)
557. EARLY EIGHTEENTH-CENTURY BRITISH LITERATURE (3) Prose and poetry in the reign of Queen Anne, with special attention to periodical publications.
560. AMERICAN ROMANTICISM (3) The romantic movement in American literature of the mid-nineteenth century.
561. STUDIES IN THE ROMANTIC MOVEMENT (3-6)
562. STUDIES IN THE LITERATURE OF VICTORIAN ENGLAND (3-6)
564. STUDIES IN NINETEENTH-CENTURY AMERICAN LITERATURE (3) The major figures treated will vary from year to year.
573. STUDIES IN TWENTIETH-CENTURY BRITISH LITERATURE (3-6) Major writers and literary movements.
574. STUDIES IN TWENTIETH-CENTURY AMERICAN LITERATURE (3-6) Major writers and literary movements.

575. JAMES JOYCE (3-6) Alternate terms: *Ulysses* and *Finnegans Wake*. Knowledge of *Dubliners* and *A Portrait of the Artist* is assumed.
576. HEMINGWAY AND FAULKNER (3) The major works.
578. SHAW (3) The plays, prose writings, and literary influence of G.B.S.
579. T. S. ELIOT (3) Major works in poetry, criticism, and drama; pertinent scholarship and criticism.
580. ANGLO-AMERICAN APPLICATIONS OF FOLKLORE IN LITERATURE (3) A detailed examination of the nature of the folktale and its implications for literature as an oral genre. Prerequisite: a basic knowledge of folklore, as taught in Engl. 196, is assumed.
581. CONTEMPORARY LITERARY CRITICISM (3)
582. HAWTHORNE AND MELVILLE (3) Detailed study of the major works of both authors and of the relationship between the two men.
583. EMERSON AND THOREAU (3) The significant prose and poetry of the chief American transcendentalists.
584. WHITMAN AND DICKINSON (3) The major texts, with special emphasis on background and language.
586. READINGS IN LITERATURE (1-12) Programs of readings designed to meet specific needs of individual students.
587. FRANKLIN AND EDWARDS (3) Studies in the lives, works, and milieu.
588. STUDIES IN AMERICAN FICTION (3-6)
589. STUDIES IN AMERICAN POETRY (3-6)
590. COLLOQUIUM (1-3)
592. STUDIES IN AMERICAN LITERARY MYTH (3) An introduction to an interpretive, interdisciplinary study of some representative themes in American literature and culture.
593. (C.Lit. 593) ANGLO-AMERICAN FOLK SONG (3) Survey of relevant literary and ethnological scholarship and field work, European and American, from the early sixteenth century to the present.
595. STUDIES IN BRITISH FICTION (3-6)
596. INDIVIDUAL STUDIES (1-6)
597. SPECIAL TOPICS (1-6)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## ENTOMOLOGY (ENT)

CHARLES W. PITTS, *Head of the Department*  
106 Patterson Building  
814-865-1895

*Degrees Conferred:* Ph.D., M.S., M.Agr.

*Graduate Faculty:* Senior Members Benton, Cameron, Hower, Kim, Mumma, Pitts, Rutschky, Smilowitz, Smyth, Snetsinger, and Yendol.

*Graduate Faculty:* Associate Members Bode, Byers, Collison, Hull, and Jubb.

A student majoring in entomology may specialize in economic entomology, forest entomology, apiculture, insect resistance in plants, arachnology, medical or veterinary entomology, biological control, insect pathology, insect transmission of plant pathogens, ecology, morphology, embryology, taxonomy, physiology, insect behavior, or chemistry of pesticides.



The enrichment requirement for the Ph.D. degree may be satisfied by taking at least 9 credits of study in a discipline other than entomology. There is no foreign language requirement for the Ph.D. degree.

For admission a student is required to have 24 credits in entomology and related biological sciences. Chemistry through organic, physics, mathematics through calculus, and statistics are required. A limited deficiency may be made up while pursuing graduate work.

Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

## ENTOMOLOGY (ENT)

- 401. MEDICAL AND VETERINARY ENTOMOLOGY (3) *Kim*
- 412. FIELD ENTOMOLOGY (3) *Rutschky*
- 414. INSECT MORPHOLOGY AND PHYLOGENY (3) *Rutschky*
- 415. INSECT PHYSIOLOGY AND BIOCHEMISTRY (3) *Mumma and Smyth*
- 416. METHODS FOR INSECT PEST POPULATION MANAGEMENT (3) *Hower*
- 418. FOREST ENTOMOLOGY (3) *Cameron*
- 425. FRESHWATER ENTOMOLOGY (3) *Kim*
- 426. IMMATURE INSECTS (3) *Shetlar*
- 435. ARACHNOLOGY (3) *Snetsinger*
- 450. INSECT CONTROL IN GREENHOUSE (1) *Shetlar and Snetsinger*
- 451. INSECT CONTROL OF ORNAMENTALS AND TURF (2) *Shetlar and Heller*
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 515. INSECT MORPHOLOGY AND SYSTEMATICS (1-3) Current theories, controversies, and advanced techniques in comparative morphology, histology, embryonic and postembryonic development, taxonomy and systematics of insects.
- 516. INSECT PHYSIOLOGY AND BIOCHEMISTRY (1-3) Selected topics in insect function and metabolism.
- 517. INSECT ECOLOGY AND BEHAVIOR (1-3) Selected aspects of the biotic and abiotic interactions of insects.
- 518. PEST MANAGEMENT (1-3) Current concepts and controversies in modern agricultural and urban pest management practice.
- 531. INSECT TOXICOLOGY (2) General principles of toxicology and survey of the actions of substances toxic to insects.
- 535. BIOLOGICAL CONTROL (3) Practical and theoretical aspects of arthropod control by entomophagous insects and the place of biocontrol in integrated control programs.
- 536. INSECT PATHOLOGY (3) Diseases of arthropods and some aspects of microbial control of insects. Prerequisite: Micrb. 1.
- 542. (Biol. 542) SYSTEMATICS (3) Principles and methods of classification, phylogeny, and speciation; taxonomic techniques; analysis of species, causal interpretation of animal diversity.
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## ENVIRONMENTAL ENGINEERING (ENV E)

ROBERT M. BARNOFF, *Head of the Department of Civil Engineering*  
212 Sackett Building  
814-865-8391

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Senior Members Aron, Barnoff, Heinsohn, Long, McDonnell, Miller, Nesbitt, Reed, Regan, Untrauer, and Unz.

*Graduate Faculty:* Associate Member Kibler.

This program prepares students for careers in (1) facility and system design; (2) systems management; (3) environmental monitoring; (4) process development; or (5) education and research in any of the environmental areas of water quality management (potable, industrial, and wastewater), water resources, management, and air pollution control.

The entering student normally should be a graduate from an accredited program in engineering.

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. Applicants must submit Graduate Record Examination Aptitude test scores. Entering graduate students for whom English is not the first language are required to have a score of at least 560 on the TOEFL (Test of English as a Foreign Language) examination. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

For the Ph.D. degree, English and communication or foreign language skills must be satisfied according to department requirements. A thesis is required for the M.S. degree. An engineering report is required for the M.Eng. degree.

The following courses offered by the Department of Civil Engineering are appropriate for students majoring in environmental engineering (course descriptions are given under Civil Engineering): C.E. 451, 462, 465, 471, 472, 474, 475, 476, 496, 497, 551, 553, 554, 564, 571, 572, 574, 575, 577, 579, 580, 596, and 597. Appropriate courses offered by other departments include Bioch. 401, 402, 425; Chem. 405; Cmp.Sc. 402; Geosc. 452; I.E. 403, 405, 509, 510; M.E. 405, 470, 521, 571; Meteo. 473, 502; Micrb. 400, 417; Nuc.E. 420; P.Path. 424; Pl.Sc. 419; Pub.A. 578; R.Pl. 400, 410, 510, 520.

## ENVIRONMENTAL POLLUTION CONTROL (E P C)

JOHN B. NESBITT, *In Charge of Graduate Programs in Environmental Pollution Control*  
226 Merrell R. Fenske Laboratory  
814-865-1415

*Degrees Conferred:* M.S., M.E.P.C., M.Eng.

*Graduate Faculty:* Senior Members Aplan, Aron, Baker, Bartlett, Barton, Buskirk, Cunningham, de Maine, de Pena, Draper, Engel, Gordon, Heicklen, Heinsohn, Hunt, Kabel, Kamon, Knight, Kroger, Long, Lovell, Massaro, McDonnell, McKee, Michael, Miller, Nesbitt, Palmer, Panofsky, Parizek, Petersen, Reethof, Regan, Schenck, Simkovich, Stahl, Stephenson, Tarbell, Thomson, Unz, Walker, White, Witzig, and Zarkower.

*Graduate Faculty:* Associate Members Bienvenue, Davis, DeTar, Ferguson, Goodwin, Jarrett, Kibler, Mayers, Patton, and Thuring.

*Graduate Faculty, Capitol Campus:* Senior Members Bissinger, Cole, Ferguson, Hand, McDermott, McKenna, and Skok.

*Graduate Faculty, Capitol Campus:* Associate Members Brown, Buskirk, Chisholm, Munzenrieder, Murty, Poore, Przybylski, Rao, Simko, Wagner, and Woodruff.



This intercollege program, available at both the University Park and Capitol campuses, deals with the various aspects of the control of air and water pollution and the disposal of solid wastes. Options in air, water, solid waste, and occupational health are available. Graduate instruction is under the direction of an interdisciplinary faculty committee and the departments participating in the program. The graduate faculty consists of members who have a teaching and/or research interest in the area of environmental pollution control.

Students are required to pass 9 credits of core courses: C.E. 472, Water Pollution Control; C.E. 476, Solid Waste Management; and M.E. 470, Fundamentals of Air Pollution. In addition, they must select at least 21 of their total credits from a recommended course list and schedule the environmental pollution control seminar (E.P.C. 590) for three terms. If the option to prepare a thesis is selected, the research topic must be in the area of environmental pollution control and at least 6 credits of research must be taken in the department with which the student is affiliated. Students who select the nonthesis option must submit a paper. The student's adviser, the department head, and the E.P.C. program chairman determine the requirements of the paper.

Admission will be granted upon recommendation of the head of the academic department with which the student plans to affiliate and the E.P.C. program chairman. Normal admission requirements include mathematics through integral calculus, plus two courses each in both general physics and chemistry. There is no foreign language requirement. Students with a 2.75 junior-senior average and with appropriate backgrounds in mathematics and science will be considered for admission. The best-qualified applicants will be accepted. Exceptions to the minimum 2.75 grade-point average may be made for students with special backgrounds, abilities, and interests. Entering graduate students for whom English is not the first language are required to have a score of at least 560 on the TOEFL (Test of English as a Foreign Language) examination.

## **ENVIRONMENTAL POLLUTION CONTROL (E P C)**

590. COLLOQUIUM (1-3)

## **EXTENSION EDUCATION (EXTED)**

DARYL K. HEASLEY, *Acting Chairman of the Committee on Extension Education*  
204 Weaver Building  
814-865-0455

*Degrees Conferred:* M.Agr., M.Ed.

*Program Committee:* Heasley, Ritter, and Shellenberger.

*Cooperating Faculty:* Baylor, Cole, Kuhn, Lindley, Sherritt, Snetsinger, and Wuest.

This program is designed primarily to meet the needs of professionals in various extension, vocational, and adult education positions. The purpose is to educate individuals to develop attitudes, understandings, and competencies which enable them to become more effective professionals. The advisory committee will assist the student in establishing goals, planning a program of study, selecting appropriate courses, and developing a professional paper within the requirements of the degree program.

For either degree a minimum of 30 credits is required, including a professional paper. These credits should be distributed as follows: 12 credits in extension techniques, communication, and education; 3-4 credits in statistics; at least 6 credits in a minor area of interest; up to 6 credits as electives; and 3 credits for the professional paper. For the M.Ed. degree a minimum of 6 credits in education courses is required. It is suggested that 12 of the 27 credits in course work be taken at the 500 level. A maximum of 10 credits can be earned as a nonresident student.

Admission requirements include a baccalaureate degree from an accredited institution, with the student having a strong background in agriculture, home economics, community development, or adult education, and a minimum of 12 credits in the social sciences. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

Graduate Record Examinations scores are required by the Graduate School.

## EXTENSION EDUCATION (EXTED)

515. (R.Soc. 515) THE COOPERATIVE EXTENSION ORGANIZATION (3) The Cooperative Extension Service as a social system, with emphasis on techniques of organization and program development. Prerequisite: 9 credits in education, communication, and/or social sciences. *Thomson*

## FOOD SCIENCE (FD SC)

PHILIP G. KEENEY, *Interim Head of the Department*  
111 Borland Laboratory  
814-865-5444

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Beelman, Dimick, Keeney, Kroger, Kuhn, MacNeil, Mason, Mast, McCarthy, Sink, Thompson, and Ziegler.

*Graduate Faculty:* Associate Members Forsythe, Glass, and Kilara.

Opportunities are available for study in the fields of biochemistry and metabolism, food chemistry (carbohydrates, lipids, proteins, enzymes), microbiology, quality control, flavor control and acceptance, product evaluation, and processing. Special emphasis can be devoted to dairy, meat, plant, and poultry products, and other specific food commodities.

The requirements for the M.S. and Ph.D. programs are detailed in the Department of Food Science's publication, *Graduate Programs in Food Science*. The communication and foreign language requirement for the Ph.D. degree may be satisfied by demonstration of an intermediate knowledge of one foreign language or through completion of three courses in English language communication.

Prerequisite to graduate work is the completion of an undergraduate degree in food science, biochemistry, microbiology, or other related areas. The undergraduate program must include calculus, organic chemistry, microbiology, and general physics. Students may be admitted with deficiencies but are required to make them up without degree credit. Students who present a 3.00 junior-senior average will be considered for admission to the program, subject to the limitations of the physical facilities. Exceptions may be made for students with special backgrounds, abilities, and interests.

In addition to the courses listed below, the following courses are available in food science: Ag.E. 412, 413, 414, 423, 503; A.I. 431; A.Ntr. 401; D.Sc. 427.

## FOOD SCIENCE (FD SC)

- 400. FOOD CHEMISTRY (3)
- 403. QUALITY ASSURANCE AND SANITATION (3)
- 404. SENSORY EVALUATION OF FOODS (2)
- 405. THERMAL PROCESSING (2)
- 407. FOOD TOXINS (2)
- 408. APPLIED FOOD MICROBIOLOGY (2)
- 409. LABORATORY IN APPLIED FOOD MICROBIOLOGY (2)
- 410. CHEMICAL METHODS OF FOOD ANALYSIS (4)
- 415. MEAT SCIENCE AND TECHNOLOGY (3)
- 490. UNDERGRADUATE SEMINAR (1)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

505. CONCEPTS OF PRODUCT DEVELOPMENT (2) Procedures and problems encountered in the development of new and modified food products. Idea generation through development, testing, and commercialization.

507. FOOD QUALITY, FOOD STANDARDS, AND CONSUMER PROTECTION (2) Problems of the food industry relating to contamination and quality of food products.



508. **FOOD PROTEINS AND ENZYME TECHNOLOGY (3)** Properties and uses of proteins and enzymes in foods and food processing.
515. **EXPERIMENTAL MEAT SCIENCE AND MUSCLE BIOLOGY (2-6)** Experimental and theoretical aspects of meat science, meat product/process systems, and the quantitative biology of muscle systems used for food. Prerequisite: Fd.Sc. 400 or 415.
521. **RADIOBIOLOGY (3)** Radioactivity: its nature, interaction with matter, measurement, and quantification; the use of isotopes as tracers in biological systems.
522. **RESEARCH PROCEDURES IN FOOD SCIENCE (3)** Research problems and methods in food science with major emphasis on food chemistry.
590. **COLLOQUIUM (1-3)**
596. **INDIVIDUAL STUDIES (1-6)**
597. **SPECIAL TOPICS (1-6)**
602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)**

## FOREST RESOURCES (FOR R)

ROBERT S. BOND, *Director of the School of Forest Resources*  
101 Ferguson Building  
814-865-7541

*Degrees Conferred:* Ph.D., M.S., M.Agr., M.F.R.

*Graduate Faculty:* Senior Members Baldwin, Blankenhorn, Bond, Bowersox, DeWalle, Gerhold, Hutnik, Labosky, Lynch, Myers, Shipman, Sopper, Steiner, Storm, Turner, and Twilight.

*Graduate Faculty:* Associate Members Corbett, Daugherty, Halverson, Heisler, Johnson, Kelly, Kersavage, McCormick, Melton, Rader, Sharp, Strauss, Tzilkowski, and Wakeley.

The Doctor of Philosophy and the Master of Science degree programs are oriented toward research, education, and scientific technology in the professions of forest products, forestry, and wildlife management. The foreign language requirement for the Ph.D. degree may be satisfied by demonstrating competence in one foreign language equivalent to passing three college-level courses.

The Master of Forest Resources is a professional degree which emphasizes application of knowledge through managerial practices involving forest resources, industries, or the natural environments of communities and recreational areas.

The Master of Agriculture is intended to enable students to develop skills as professionals in the communication of technical knowledge. Candidates will elect a minimum of 15 credits of graduate-level courses in communication skills from courses in departments such as Agricultural Education, Instructional Media, Journalism, Recreation and Parks, Speech Communications, English, and Theatre. Any deficiencies in a student's resource specialty, as judged by his or her advisory committee, must be remedied. An acceptable paper on a selected professional problem or a report of internship training worth 3 credits or more is also required.

A thesis is required for the M.S. and Ph.D. degrees, and an original paper is required for the M.F.R. degree. Most programs of study are strengthened by including appropriate courses offered by related departments.

Faculty expertise, laboratories, and outdoor research facilities are available to support specialization in a variety of fields. Possibilities for specialization are indicated in part by the courses listed under forest products, forestry, and wildlife, and by related courses in agricultural economics, agronomy, animal nutrition, biology, business administration, chemical engineering, computer science, ecology, economics, entomology, environmental pollution control, environmental resource management, genetics, horticulture, industrial engineering, landscape architecture, meteorology, physiology, plant pathology, polymer sciences, recreation and parks, regional planning, or statistics.

For admission, an applicant should have at least a 2.75 grade-point average, a 3.00 junior-senior av-

erage, and courses that are basic to the individual's field of specialization. Ordinarily these include 12 credits in communication, 12 credits in social sciences and humanities, 12 credits in quantification including calculus and statistics, 9 credits in physical sciences, 9 credits in biological sciences, and 18 credits in forest products, forestry, wildlife, or related courses. Graduate Record Examination scores, three reference reports (forms supplied on request), and a brief statement describing the applicant's academic goals, career interests, and special qualifications are required. The best-qualified applicants will be accepted up to the number of spaces available. Exceptions to admission requirements may be made for students with special backgrounds, abilities, and interests.

Students in this program may elect the dual-title degree program option in operations research for the Ph.D. and M.S. degrees (see p. 249).

## FOREST PRODUCTS (F P)

- 401. WOOD SCIENCE CONCEPTS (2)
- 402. WOOD SCIENCE PRACTICUM (1)
- 411. WOOD-ENVIRONMENTAL RELATIONSHIPS (3)
- 412. WOOD IN STRUCTURES (3)
- 413. THE CHEMISTRY OF WOOD (3)
- 414. PULP AND FIBER TECHNOLOGY (3)
- 420. PROCESSING AND MACHINING OF WOOD AND WOOD PRODUCTS (2)
- 421. GLUING AND FINISHING WOOD (2)
- 422. DRYING OF WOOD (2)
- 423. DETERIORATION AND PROTECTION OF WOOD PRODUCTS (2)
- 424. COMPOSITE WOOD PRODUCTS (2)
- 432. FOREST PRODUCTS MANUFACTURING SYSTEMS (3)
- 435. FOREST PRODUCTS PRODUCTION MANAGEMENT (3)
- 439. PULP AND TIMBER HARVESTING (3)
- 490. FOREST PRODUCTS COLLOQUIUM (1)
- 495. FOREST PRODUCTS INTERNSHIP (1-6)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 502. WOOD FIBERS (3) Identification and measurement of physical and chemical characteristics of wood fibers used in paper or dissolving pulps.
- 511. PHYSICAL PROPERTIES OF WOOD AND FIBERS (2) Theories of accessibility, sorption, dimensional stabilization, diffusion, and permeability of cellulosic fibers and solid wood. Prerequisite: F.P. 411.
- 513. WOOD CHEMISTRY (3) Treatment of the chemical components of wood, their distribution and reactions. Prerequisite: F.P. 413.
- 530. FOREST PRODUCTS INDUSTRIAL OPERATIONS ANALYSIS (2) Research methods with emphasis on programming, simulation, and waiting line problems. Prerequisite: F.P. 435.
- 531. MECHANICAL BEHAVIOR OF WOOD (3) Time-dependent properties, theory of failure, rheologic properties, and theory of the mechanical behavior of wood and structural composites.
- 532. THEORY OF ADHESION (3) Theory of adhesion as it pertains to bonding of wood, paper-based laminates, fibers, and bonding of wood to dissimilar materials.
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)



**FORESTRY (FOR)**

- 403. DENDROLOGY (3)
- 416. FOREST RECREATION (3)
- 421. SILVICULTURE (3)
- 440. FOREST ECONOMICS AND FINANCE (3)
- 450. INTRODUCTION TO OPERATIONS RESEARCH (3)
- 455. INTRODUCTION TO REMOTE SENSING (3)
- 466. FOREST RESOURCE MANAGEMENT (3)
- 470. WATERSHED MANAGEMENT (3)
- 480. POLICY AND ADMINISTRATION (3)
- 495. FORESTRY INTERNSHIP (1-6)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 508. FOREST ECOLOGY (3) The forest ecosystem, variations in space and time, classification, ordination techniques, dynamic aspects such as energy flow and nutrient cycling.
- 512. FOREST GENETICS (3) Qualitative and quantitative genetic principles and research methods applied in tree breeding.
- 517. FOREST MICROCLIMATOLOGY (3) A quantitative treatment of climate near the ground, with special reference to the role of forests and terrain. Prerequisite: Phys. 202.
- 519. FOREST HYDROLOGY (3) Influence of forest cover on the disposition of precipitation and the application of hydrologic principles and techniques to forest watersheds. Prerequisites: For. 308, C.E. 51.
- 520. SNOW HYDROLOGY (2) Role of snow and ice in the hydrologic cycle with special emphasis on effects of forests and land use. Prerequisite: For. 470 or 3 credits of hydrology.
- 521. ADVANCED SILVICULTURE (3) Specific silvicultural practices for the establishment and manipulation of forest stands with respect to recent developments and research needs. Prerequisite: For. 421.
- 525. FOREST LAND USE (3) Concepts of supply and demand for forest lands and their allocation to alternative uses. Prerequisites: For. 466 or Ag.Ec. 421; or Geog. 405 and 3 credits in economics.
- 550. MULTIVARIATE ANALYSIS IN FORESTRY RESEARCH (3) Analysis and interpretation of research data involving several response variables. Includes computational considerations for large data sets. Prerequisite: Stat. 402.
- 555. MULTISPECTRAL REMOTE SENSING (3) Computer analysis of data from nonimaging remote sensors as applied to mapping of natural resources and land use. Prerequisites: Cmp.Sc. 101, For. 455.
- 560. TIMBER MANAGEMENT (3) Technical methods in the organization and control of the forest property for timber production.
- 575. APPLICATIONS OF FOREST ECONOMICS AND FINANCE (3) Survey of situations in forestry where business problems and particular circumstances of production, value, and costs are currently significant. Prerequisite: For. 440.
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

NOTE: *See also Wildlife Management.*

## FRENCH (FR)

RICHARD L. FRAUTSCHI, *Head of the Department*  
316 Burrowes Building  
814-865-1492

*Degrees Conferred:* Ph.D., D.Ed., M.A., M.B.A./M.A. in French Studies, M.S. in Business Administration/M.A. in French Studies

*Graduate Faculty:* Senior Members Brault, Chapman, Frautschi, Hale, Knight, Norton, and Ward.

*Graduate Faculty:* Associate Members Ariew, Boisset, Bragger, Danahy, and Makward.

This program offers training in language, literature, linguistics, and civilization. A candidate for the M.A. degree may select a program of study emphasizing language with cultural emphasis or literature. A reading knowledge of a second foreign language and written and oral comprehensive examinations are required. The candidate may submit either a thesis or a term paper. If the latter is chosen, 6 additional credits in 500-level courses must be scheduled. The M.A. degree (or equivalent) is normally a prerequisite to doctoral candidacy.

The department, in cooperation with the College of Business Administration, offers concurrent master's degree programs in French studies and in business administration to provide training in both business and French studies for students who plan careers in international business. The Master of Business Administration/M.A. in French Studies program is open to graduates of accredited colleges and universities. Candidates will first be admitted as students seeking the M.B.A. or seeking the M.A. in French. Assisted by graduate advisers in both programs, students will determine the appropriate entry courses in the second program, including an intensive summer language program, prior to official acceptance by both programs as concurrent degree candidates.

The M.B.A./M.A. in French Studies program consists of a minimum of 60 credits: 36 in M.B.A. courses and 24 in graduate French language and culture. Required courses in business will be taken in the following sequence: tool and theory courses (Mgmt. 531, Q.B.A. 510, Acctg. 511, Q.B.A. 521, Econ. 500, B.A. 517); functional courses (Mktg. 500, 510, Fin. 531); "capstone" courses (B.A. 555, 577). International business courses at the University of Nice may be substituted for B.A. 555. Required courses in French are language (minimum of 9 credits): Fr. 408, 507, 508, 510; culture and civilization (minimum of 9 credits): Fr. 530, 531, 595; electives (minimum of 6 graduate credits).

All concurrent degree candidates will prepare a paper in both French and English (no credits). A final oral examination may be recommended.

The M.S. in business administration/M.A. in French studies permits specialized interests in an area of business administration as well as advanced proficiency in Francophone language and culture. A B.A. or B.S. degree with a minimum of 30 credits (or equivalent) in French and another 30 credits (or equivalent) in business administration/economics are prerequisites. Admission is contingent upon approval by the College of Business Administration and by the Department of French. The program consists of 54 graduate credits: 21-27 credits in business and 24-30 credits in French. Candidates will specialize in a major field of business administration. Required courses in French are Fr. 508, 510, 595, one graduate course in metropolitan literature, plus at least 9 elective graduate credits.

A master's thesis in both French and English is recommended. However, candidates may present a special paper (no credits) in both languages. A final oral examination will be scheduled.

Candidates in both concurrent degree programs are urged to spend one or more terms of study at the University of Nice in work-study programs approved for Penn State students. Candidates should consult with their graduate advisers and the Office of Foreign Studies regarding application procedures.

The D.Ed. degree is structured for students preparing careers emphasizing teaching, curriculum design, and administration in secondary and postsecondary education. Of the 90 required graduate credits, a minimum of 60 (including M.A. credits) must be acquired in French courses and another 15 in the College of Education. A reading knowledge of a second foreign language is also required. A thesis focusing on a pedagogical topic is selected and may be supervised by faculty in both French and education.

The Ph.D. degree prepares candidates for careers in teaching and research at the college level. A



minimum of 66 credits (including M.A. credits) is required in graduate course work, 36 of which must be distributed in metropolitan literature. Candidates may specialize in French literature, linguistics, francophone literature, or, with special permission, interdisciplinary study in the humanities, social sciences, or fine arts. The communication and foreign language requirement for the Ph.D. degree may be satisfied by at least a reading knowledge of two foreign languages other than French.

The minimum requirement for admission to an advanced degree program will normally be 36 credits of post-intermediate work in language and literature. Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. A brief tape recording of an original composition in French must be presented before admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

## FRENCH (FR)

\*1G. ELEMENTARY FRENCH FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees.

\*2G. ELEMENTARY FRENCH FOR GRADUATE STUDENTS (3) Continuation of Fr. 1G with reading practice.

500. INTRODUCTION TO OLD FRENCH (3) Analysis of the phonology, morphology, and syntax of Old French based on early literary monuments. *Brault*

503. FRENCH PHONOLOGY (3) Articulatory and acoustic correlates of distinctive features; synchronic dialectology; phonology in generative grammar. *Boisset*

504. FRENCH MORPHOLOGY AND SYNTAX (3) Principles of segmentation and decomposition; tagmemics and transformation theory; morphophonemics. *Boisset*

505. SEMANTIC THEORY OF THE FRENCH LANGUAGE (3) The goals of semantic description; systematic interrelation of semantic generalizations; empirical and methodological constraints. *Boisset*

507. COMPOSITION (3) Review of sentence and paragraph composition with special emphasis on idiomatic structures. *Bragger*

508. FRENCH BUSINESS COMMUNICATIONS (3 per term, maximum of 6) Written and oral elements of French commerce and industry. Prerequisite: Fr. 510. *Boisset*

510. STYLISTIQUE AVANCÉE (3) Study of rhetorical figures and expository style in prose and poetry through *dissertation* and *explication*.

511. READINGS IN OLD FRENCH (3 per term, maximum of 6) A survey of French literature to 1300, focusing in alternate terms on either the twelfth or the thirteenth century. *Brault*

512. LATE MEDIEVAL FRENCH LITERATURE (3) The non-dramatic literary genres of the late Middle Ages, with reference to their cultural context and social function. *Knight*

516. THE SONG OF ROLAND (3) Seminar in the Old French *Chanson de Roland*, with emphasis on the problems of textual criticism and literary analysis. *Brault*

518. MEDIEVAL FRENCH DRAMA (3) The development of French drama from its liturgical origins to the flourishing comic theatre of the late Middle Ages. *Knight*

526. AGE OF RABELAIS (3) Notions of literary creativity in the context of early sixteenth-century French Humanism: readings from Rabelais, Marguerite de Navarre, Scève. *Norton*

528. AGE OF MONTAIGNE (3) Literary culture of Renaissance France in the context of social and political crisis; readings from Montaigne, DuBellay, Ronsard, and Sponde. *Norton*

529. SEMINAR IN RENAISSANCE LITERATURE (3 per term, maximum of 6) Intensive study of various French Renaissance writers in relation to selected artistic issues of the period. *Norton*

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\*No graduate credit is given for this course.

530. LA FRANCE CONTEMPORAINE (3) A comprehensive cross-sectional view of French society and its institutions since World War II. *Bragger*
531. FRANCOPHONE CULTURE (3 per term, maximum of 6) Concept of francophone; French minorities in Europe and North America; role of French language in Africa, Middle East, Far East. *Hale*
533. SEVENTEENTH-CENTURY PROSE AND POETRY (3) The development of classicism; its apogee and decline as seen in the works of major prose writers and poets.
534. MOLIÈRE (3) The literary achievement of Molière, the comic playwright, director, actor, and founder of the Comédie Française.
535. SEVENTEENTH-CENTURY FRENCH TRAGEDY (3) The development and triumph of tragedy as a literary genre with special emphasis on the achievement of Corneille and Racine.
540. VOLTAIRE AND HIS CONTEMPORARIES (3) The artistic and philosophical evolution of Voltaire as seen in the tragedy, the philosophical tale, and poetry. *Frautschi*
541. ROUSSEAU AND HIS CONTEMPORARIES (3) Rousseau's rationalistic critique of civilization; his sentimental rehabilitation of the individual, family, state; Rousseau, precursor of romanticism. *Frautschi*
543. SEMINAR: STUDIES IN THE ENLIGHTENMENT (3 per term, maximum of 6) Discourse and thematic analysis of selected works of French Enlightenment genres: essay, drama, fiction, poetry. *Frautschi*
561. FRENCH ROMANTICISM (3) The romantic movement in French literature with emphasis upon its major exponents in prose and poetry. *Danahy*
563. FRENCH REALISM (3) The realistic movement in French literature with emphasis upon its major exponents in prose and poetry. *Danahy*
565. SEMINAR: NINETEENTH-CENTURY STUDIES (1-6) Various nineteenth-century French writers considered in relation to selected esthetic and cultural problems raised during the period. *Danahy and Ward*
569. MASTERS OF TWENTIETH-CENTURY FRENCH LITERATURE (3-6) Major literary figures of contemporary French literature. *Makward*
570. MODERN FRENCH POETRY (3 per term, maximum of 6) Historical overview through readings from major poets since Baudelaire; introduction to basic concepts in criticism of poetry.
571. FRENCH LITERARY CRITICISM FROM SAINTE-BEUVE TO PRESENT (3) Evolution of French literary criticism from Sainte-Beuve, the "father" of modern literary criticism, to contemporary critics.
572. SEMINAR: TWENTIETH-CENTURY FRENCH LITERATURE (3 per term, maximum of 6) Specialized consideration of contemporary writers; for advanced students.
581. THEORY AND TECHNIQUES OF TEACHING FRENCH (1-6)
595. ANALYSIS OF FRENCH CIVILIZATION (3-6) French cultural aspects, other than language and literature, conducted in French with the collaboration of specialists outside the French department.
596. INDIVIDUAL STUDIES (1-6)
597. SPECIAL TOPICS (1-6)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)



## FUEL SCIENCE (F SC)

PHILIP L. WALKER, JR., *In Charge of Graduate Programs in Fuel Science*  
320 Steidle Building  
814-865-6511

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Austin, Given, Palmer, Vastola, and Walker.

*Graduate Faculty:* Associate Members Jenkins and Reuther.

Graduate work in fuel science provides advanced professional knowledge and research opportunities in the characteristics and utilization of fuels, including their conversion to energy, to other fuels, or to other materials.

Well-instrumented research facilities are available for investigation of the chemical and physical characteristics of coals, fundamentals of coal gasification and liquefaction, flame dynamics in practical combustion systems, industrial fuel efficiency, chemistry and physics of basic combustion phenomena, chemical kinetics of fast gaseous reactions, formation and removal of polluting species in combustion processes, physics and chemistry of carbonaceous solids, organic geochemistry of plant-derived sediments, modeling of energy systems, and electrochemical energy conversion. Students can plan a wide variety of programs of study to suit individual needs; coherent interdisciplinary programs are encouraged. The nonthesis option is available for the M.S. degree.

Competency in a foreign language is not required for the Ph.D. degree. Candidates are expected to demonstrate high proficiency in both written and spoken English.

Applications will be accepted from persons having degrees in the basic or applied physical sciences or in engineering. Students with a 2.75 junior-senior average normally will be considered for admission. Exceptions may be made for students with special abilities, interests, or backgrounds, such as extensive industrial experience in fuels or combustion.

## FUEL SCIENCE (F SC)

- 421. FLAMES (3) *Palmer*
- 422. COMBUSTION ENGINEERING (3) *Reuther*
- 424. ENERGY AND FUELS IN TECHNOLOGICAL PERSPECTIVE (3) *Vastola*
- 430. AIR POLLUTANTS FROM COMBUSTION SOURCES (3) *Reuther*
- 431. THE CHEMISTRY OF FUELS (3) *Given*
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 501. STRUCTURE AND PROPERTIES OF COALS (3) Modern developments in coal structural studies and relationships between structure and properties of coal and coal-derived solids. Prerequisite: F.Sc. 431. *Jenkins*
- 502. COAL CONVERSION PROCESSES (3) Review of current scientific and technological developments in coal conversion to gaseous and liquid fuels. Prerequisite: F.Sc. 431. *Jenkins*
- 506. CARBON REACTIONS (3) Current approaches to heterogeneous reactions in combustion and gasification of carbonaceous solids, including those derived from coal and petroleum sources. Prerequisite: Chem. 452. *Walker*
- 512. HIGH-TEMPERATURE KINETICS AND FLAME PROPAGATION (3) Laminar and turbulent premixed and diffusion flames; gaseous detonations; rate processes in high-temperature gases. Prerequisite: F.Sc. 421. *Palmer*
- 520. THERMODYNAMICS AND KINETICS OF FUEL EFFICIENCY (3) Thermodynamic and kinetic constraints on efficiencies of thermal systems; efficiency ratios; furnace analysis; radiation in furnaces, applications and examples. Prerequisite: study of thermodynamics at the upperclass or graduate level. *Reuther*

522. FLAME DYNAMICS IN COMBUSTORS (3) Mixing and reaction in combustion chambers; combustor analysis; residence time distributions; perfectly and well-stirred combustors; models and experiments. *Reuther*

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

NOTE: Courses in the use of X-ray diffraction, electron microscopy, spectroscopy, and electronic instrumentation in fuel science studies are listed under Materials Science.

## GENETICS (GENET)

HENRY D. GERHOLD, *Chairman of the Graduate Program in Genetics*  
306 Forest Resources Laboratory  
814-865-3281

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Ayers, Berlin, Bullock, Buss, Cleveland, Craig, Davidson, Deering, Docherty, Eckhardt, Fritz, Garwood, Gerhold, Goodwin, Grun, Hargrove, C. W. Hill, R. R. Hill, Hunt, Jacob, M. Johnson, Jones, Keith, Lang, MacCluer, MacKenzie, Marshall, N. Nelson, R. Nelson, Person, Rapp, Risius, Schengrund, Shannon, Shenk, Shiman, Snipes, Starling, Steiner, J. Taylor, W. Taylor, Tevethia, Therrien, Todd, Vesell, Weisz, Wilson, Wright, Zagon, and Zimmerman.

*Graduate Faculty:* Associate Members Berg, Dyke, Ferguson, Hardison, A. Hopper, J. Hopper, Ladda, Liu, McCarthy, Petters, Pfeifer, Porter, Rose, Schlegel, S. Smith, Stevens, Tu, and W. J. White.

The intercollege program in genetics includes faculty from the Colleges of Agriculture, the Liberal Arts, Medicine, and Science who serve as major advisers and committee members. Applicants are encouraged to contact any faculty member who may be a prospective major adviser. Assistantship or fellowship applications should be submitted by January. Courses may be taken at either University Park or the Hershey Medical Center.

Opportunities for graduate study and research are available in biochemical, developmental, human, microbiological, viral, molecular, and population genetics; cytogenetics; pharmacogenetics; and breeding of plants or animals. Organisms available for research include fungi, bacteria, viruses, fish, rodents, birds, domestic animals, humans, forest trees, and grain, forage, and horticultural plants. The committee appointed for each student, with the approval of the program chairman, has the responsibility for determining course work, specific requirements in communication skills exceeding the minimum, and research acceptable for satisfying degree requirements. The requirement in communication and foreign language skills for the Ph.D. degree may be satisfied by fulfilling the requirement of the thesis adviser's department or program.

Students with a grade-point average of 3.00 or better and with appropriate academic backgrounds in biology, science, and communications courses will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. Students with limited deficiencies may be admitted, but they must make up such deficiencies concurrently with their graduate studies.

The following genetics courses are available: Agro. 411, 509, 510, 511; An.Sc. 422, 455; Anthy. 400, 500; Bioch. 514; B.Chem. 503; Biol. 422, 426, 427, 428, 429, 465, 533; M.C.B. 430, 589; C.Med. 503; For. 512; Hort. 407, 444, 514; Micrb. 516; Micro. 553, 556; Ped. 525, 526; Pharm. 515, 540; P.Path. 543. Twelve credits in these courses, plus at least 3 credits in acceptable statistics courses, and 3 credits per year in genetics seminar (Genet. 590 or Pharm. 515) are required for the M.S. degree in genetics or a minor in genetics for a Ph.D.; 15 credits in these courses and 3 credits per year in genetics seminar are required for a Ph.D. major in genetics. Transfer credits for certain courses in genetics may be accepted as substitutes for the above-listed courses.



**GENETICS (GENET)**

590. COLLOQUIUM (1-3)

**GEOGRAPHY (GEOG)**

RONALD ABLER, *Head of the Department*  
 302 Walker Building  
 814-865-3433

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Abler, Downs, Erickson, Gould, Knight, Lewis, Miller, Rodgers, Simkins, Wernstedt, Williams, Yapa, and Zelinsky.

*Graduate Faculty:* Associate Member Goodwin.

The student may concentrate in subjects that call upon the special skills and interests of the staff. Current specialties in human geography include the American landscape; behavioral geography, the cultural and human geography of Africa, Anglo-America, Southeast Asia, and the U.S.S.R.; political geography; population problems; and urban geography. Economic specialties include applied geography, communications systems, the developing world, environmental pollution control, human use of the environment, industrial location, planning, and regional economic development. Methodological specialties include cartography, computer mapping, geographical theory, methods of geographical analysis, and statistical techniques in geography. All students must have or acquire competence in cartography and statistical analysis.

For the M.S. degree, the student has the option of completing a thesis or two papers. The master's program is broadly based, designed to provide a beginning graduate student with basic training in systematic fields, as well as in geographic theory and research techniques. This basic training underlies more specialized study at the doctoral level, where a candidate selects two fields of concentration. A student may elect to specialize in the geography of a region only if faculty members have research experience in that region. The communication and foreign language requirement for the Ph.D. degree shall be satisfied in a manner approved by the candidate's doctoral committee.

Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

Students in this program may elect the dual-title degree program option in operations research for the Ph.D. and M.S. degrees (see p. 249). The M.S. in environmental pollution control with a geography specialty is also available.

Qualified students also may select population issues as an optional area of specialization. In addition to departmental admission requirements, the Population Issues Research Center evaluates the student's interest and aptitude for the training program, which consists of a minimum of 21 credits of interdisciplinary course work in population.

**GEOGRAPHY (GEOG)**

- 401. HISTORICAL GEOGRAPHY OF NORTH AMERICA (3) *Lewis or Zelinsky*
- 402. CULTURAL AND ANTHROPOGEOGRAPHY (3) *Zelinsky*
- 405. GEOGRAPHY OF POPULATION (3) *Simkins or Zelinsky*
- 406. HUMAN USE OF ENVIRONMENT (3) *Knight*
- 410. CARTOGRAPHY — MAP DESIGN AND CONSTRUCTION (3) *Abler*
- 411. ADVANCED CARTOGRAPHY (3) *Abler*
- 412. THE GEOGRAPHY OF THE FUTURE (3) *Abler*
- 413. BEHAVIORAL APPROACHES TO GEOGRAPHY (3) *Downs*
- 416. LOW-ENERGY LIVING (3) *Goodwin*
- 420. URBAN GEOGRAPHY (3) *Erickson*

427. GEOGRAPHY OF THE SOVIET UNION (3) *Rodgers*
433. REGIONAL CLIMATOLOGY (3) *Wernstedt*
434. REGIONAL PHYSIOGRAPHY (3) *Lewis*
440. GEOGRAPHY OF MIDDLE AMERICA (3) *Simkins*
441. GEOGRAPHY OF SOUTH AMERICA (3) *Simkins*
442. REGIONAL SYSTEMS IN EUROPE (3) *Miller*
443. GEOGRAPHY OF THE ORIENT (3) *Wernstedt*
444. GEOGRAPHY OF AFRICA (3) *Knight*
445. GEOGRAPHY OF SOUTHERN ASIA (3) *Wernstedt*
450. DEVELOPMENT OF GEOGRAPHIC THOUGHT (3) *Abler*
451. MAP INTERPRETATION (3) *Lewis*
452. INTERPRETATION OF AERIAL PHOTOGRAPHS (3) *Goodwin*
454. SPATIAL ANALYSIS I (3) *Gould or Williams or Yapa*
455. SPATIAL ANALYSIS II (3) *Gould or Williams or Yapa*
457. GEOGRAPHIC DATA SYSTEMS (4) *Williams*
458. COMPUTER MAPPING (4)
460. POLITICAL GEOGRAPHY (3) *Williams*
470. INDUSTRIAL LOCATION AND DEVELOPMENT (3) *Rodgers*
475. GEOGRAPHY OF COMMUNICATIONS SYSTEMS (3) *Abler*
495. INTERNSHIP (1-13)
496. INDEPENDENT STUDIES (1-12)
497. SPECIAL TOPICS (1-6)
499. DIRECTED READINGS (1-9)
  
500. INTRODUCTION TO GEOGRAPHIC RESEARCH (1-3)
  
502. REGIONAL THEORY (3) Taxonomic methods of uniform-functional regionalization; canonical linkages; intraregional relationships; Wilson models of macrocanonical ensembles.
  
504. PHYSICAL GEOGRAPHY SEMINAR (3-12) The examination of current problems and theories in physical geography through critical discussion of the literature and student research.
  
505. ECONOMIC GEOGRAPHY SEMINAR (3-12) The examination of current problems and theories in economic geography through critical discussion of the literature and original student research.
  
508. CULTURAL GEOGRAPHY SEMINAR (3-6) The exploration of current problems and theory in cultural geography through critical discussion of the literature and original student research.
  
509. POPULATION GEOGRAPHY SEMINAR (3) Selected problems in population geography with emphasis on analysis and presentation of data. Prerequisite: Geog. 405.
  
510. ANALYTIC CARTOGRAPHY (3) Computer graphics, geographical matrix operations, response functions, sampling resolution, quantization, map generalization, pattern recognition, generalized spatial partitionings, and map projections. Prerequisites: Geog. 454, 455.
  
517. GEOGRAPHIC MODELING (1) Spatial modeling, mapping, and transformations of elementary geographic problems.
  
520. METROPOLITAN ANALYSIS (3) Land use models, urban factorial ecology; intraurban movements; urban renewal, ghetto structure, residential change; commercial structure, blight. Prerequisite: Geog. 420 or 454.
  
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-6)
597. SPECIAL TOPICS (1-6)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)



## GEOSCIENCES (GEOSC)

C. WAYNE BURNHAM, *Head of the Department*  
503 Deike Building  
814-865-6711

There are three graduate degree programs to which a student can be admitted: geochemistry and mineralogy, geology, and geophysics. Transfer from one of these majors to another is possible, provided the basic admission requirements of the program into which the student is transferring are met.

For admission applicants are required to submit the results of the Graduate Record Examination and are generally expected to have a bachelor's degree in some branch of the natural or physical sciences, engineering, or mathematics. An applicant also is expected to have completed standard introductory courses in geosciences, chemistry, physics, and mathematics through integral calculus, plus 15 credits of intermediate-level work in one or a combination of these subjects. Greater than minimal preparation within these limits may be required in chemistry and mineralogy for the geochemistry and mineralogy major; in geology and biology for the geology major; and in mathematics and physics for the geophysics major. Applicants who have taken somewhat less than the indicated minimum in these subjects may be admitted but must make up their deficiencies concurrently with their graduate studies. Students with special backgrounds, abilities, and interests whose undergraduate grade-point average in courses pertinent to geosciences is below a 3.00 will be considered for admission only when there are strong indications that a 3.00 average can be maintained at the graduate level. The student has the option of a thesis or a paper for the M.S. degree.

### GEOSCIENCES (GEOSC)

- 401. GEOLOGIC PERSPECTIVES OF INDUSTRIAL ACTIVITIES (2)
- 402. (Meteo. 446) NATURAL DISASTERS SEMINAR (2)
- 403. GEOLOGICAL ASPECTS OF ENVIRONMENTAL PROBLEMS (3) *Dachille*
- 404. GEOLOGY OF THE SOLAR SYSTEM (3) *Dachille*
- 408. (Mat.Sc. 408) X-RAY DIFFRACTION (3) *Dachille*
- 409. CRYSTALLOGRAPHY AND OPTICAL MINERALOGY (3) *Eggler and Thornton*
- 411. (Mat.Sc. 411) INSTRUMENTAL TECHNIQUES APPLIED TO MATERIALS AND MINERAL SCIENCES PROBLEMS (1-8)
  - Unit A. X-RAY DIFFRACTION
  - Unit B. TRANSMISSION ELECTRON MICROSCOPY
  - Unit C. SPECTROSCOPY
  - Unit D. ELECTRON MICROPROBE ANALYSIS
  - Unit E. SCANNING ELECTRON MICROSCOPY
  - Unit F. ABSORPTION SPECTROSCOPY
  - Unit G. ION BEAM TECHNIQUES
  - Unit I. ELECTRON SPECTROSCOPY FOR CHEMICAL ANALYSIS AND AUGER ELECTRON SPECTROSCOPY
- 415. GEOCHEMISTRY (3) *Deines*
- 416. STABLE AND RADIOACTIVE ISOTOPES IN GEOSCIENCES: INTRODUCTION (3) *Ohmoto and Deines*
- 419. INTRODUCTION TO ORGANIC GEOCHEMISTRY (3) *Given*
- 420. (Biol. 420) PALEOBOTANY (3) *Spackman*
- 421. INTRODUCTION TO COAL PETROLOGY (3) *Davis*
- 422. COAL MEASURE GEOLOGY (3) *Davis*
- 423. (Biol. 423) INTRODUCTORY PALYNOLOGY (3) *Traverse*
- 425. FOSSILS (3) *Cuffey*
- 426. PALEOECOLOGY (3) *Cuffey*
- 427. (Biol. 427) EVOLUTION (3) *Cuffey and Traverse*
- 430. PETROLOGY (5)
- 431. PETROGRAPHY (3)
- 434. VOLCANOLOGY (3) *Thornton*
- 436. PETROLOGY AND GEOCHEMISTRY OF SEDIMENTS (3) *Williams*
- 438. BIOGENIC SEDIMENTATION (3) *Guber*

- \*439. STRATIGRAPHY (3) *Cuffey and Williams*
- 440. MARINE GEOLOGY (3) *Schmalz*
- 442. EVOLUTION OF COASTLINES (3) *Slingerland*
- 445. COASTAL GEOLOGY (4) *Guber, Schmalz, Slingerland, and Williams*
- 451. ECONOMIC GEOLOGY (3) *Gold and Rose*
- 452. INTRODUCTION TO HYDROGEOLOGY (3) *Parizek*
- 454. GEOLOGY OF OIL AND GAS (3) *Scholten*
- 457. GEOCHEMICAL EXPLORATION (3) *Rose*
- 461. GEOLOGY OF NORTH AMERICA (3) *Wright*
- \*462. DRAINAGE BASIN ANALYSIS (3) *Gardner*
- 465. STRUCTURAL GEOLOGY (3) *Gold*
- 466. MECHANICS OF GEOLOGICAL MATERIALS (3) *Voight*
- \*470. INTRODUCTION TO FIELD GEOLOGY (3) *Gold and Wright*
- \*471. FIELD STUDIES IN NORTH AMERICA (3)
- 472. FIELD GEOLOGY (7-8)
- 473. TOPOGRAPHIC MAPS AND AERIAL PHOTOGRAPHS (1)
- 480. PHYSICS OF THE EARTH (3) *Graham*
- 482. GEOPHYSICAL WELL LOGGING (3) *Lavin*
- 484. GEOPHYSICAL SURVEYING (3)
- 487. ANALYSIS OF TIME SERIES (3) *Lavin*
- 488. POTENTIAL THEORY APPLIED TO EARTH PROBLEMS (3) *Alexander*
- 490. GEOLOGICAL SCIENCES SEMINAR (1-6 per term)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## GEOCHEMISTRY AND MINERALOGY (G M)

DERRILL M. KERRICK, *In Charge of Graduate Programs in Geochemistry and Mineralogy*  
 204 Deike Building  
 814-863-0633

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Barnes, Burnham, Dachille, Deines, Kerrick, Muan, Ohmoto, Rose, Roy, Smith, Thornton, and White.

*Graduate Faculty:* Associate Members Blencoe, Cathles, Eggler, Lasaga, and Suhr.

Areas of specialization include phase equilibria, element distribution and affiliations, isotope geochemistry, geochemical exploration, cosmochemistry, high-temperature and high-pressure geochemistry, ore-forming processes, igneous, sedimentary, and metamorphic petrology, experimental petrology and mineralogy, crystallography, crystal chemistry, X-ray mineralogy, clay mineralogy, ore mineralogy, and application of statistics in the earth sciences.

Students in this program may elect the dual-title degree program option in operations research for the Ph.D. and M.S. degrees (see p. 249).

## GEOCHEMISTRY AND MINERALOGY (G M)

502. (Geol. 502) CARBONATES IN THE MARINE ENVIRONMENT (3) Ancient carbonate rocks and recent carbonate sediments, with emphasis on modern field and laboratory methods and a multidisciplinary approach.

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\*This course includes from one to several field trips for which an additional charge will be made.



503. (Mat.Sc. 503) KINETICS OF MATERIALS PROCESSES (3) Introduction to application of transition state theory and mass transfer to the kinetics of materials and mineral processes. Prerequisites: Math. 100, Chem. 451; G.M. 521 or Mat.Sc. 501. *Lasaga*
510. METAMORPHIC PETROLOGY (2-4 per term, maximum of 6) Analysis of theoretical, experimental, and field aspects of metamorphic reactions. Prerequisites: G.M. 520, 521, and Geosc. 432. *Kerrick*
512. (Mat.Sc. 512) PRINCIPLES OF CRYSTAL CHEMISTRY (2-4) Relation of structure to ionic size and nature; influence of pressure and temperature on structure; chemical-structural defects, crystalline solutions, phase-transitions. *Roy*
- \*513. SCIENTIFIC METHOD IN GEOSCIENCE (3) Problem formulation, sampling designs, selection of variates, and comparison of techniques for analysis of aggregates.
- \*514. STATISTICAL AND ELECTRONIC DATA-PROCESSING PROCEDURES FOR GEOSCIENCE (3) Statistical analysis of experimental data using univariate and bivariate procedures.
- \*515. ORE MICROSCOPY (3) Optical and hardness measurements and phase equilibria as used in identification and interpretation of textures of ore minerals. *Barnes*
518. STABLE ISOTOPE GEOCHEMISTRY (3) Theory of isotope fractionation mechanisms; its application to a wide range of problems in the earth and planetary sciences. *Deines*
519. PHASE EQUILIBRIA IN MINERAL SYSTEMS AT HIGH TEMPERATURES (2-4) Interpretation of phase diagrams with emphasis on high-temperature oxide systems at atmospheric pressure; measurement of p-t-x, determination of equilibrium diagrams. *Muan*
520. P-T-X PHASE EQUILIBRIA (3) Phase equilibrium in mineral systems with pressure as a variable. *Eggler*
521. MINERAL EQUILIBRIA (3) A thermodynamic treatment of minerals and their reactions under geochemically important conditions of temperature and pressure. Prerequisite: Chem. 451. *Lasaga*
522. GEOCHEMISTRY OF AQUEOUS SYSTEMS (2-3) Ionic and molecular equilibria related to stabilities and solubilities of minerals: Eh-pH, PO<sub>2</sub>-pH relations applied to ground water, sea water, hydrothermal fluids. Prerequisites: Chem. 451-452; Geosc. 432, 436. *Barnes, Lasaga, and Schmalz*
- \*523. WATER-RESOURCE GEOCHEMISTRY (2-4) Topics and problems concerning the chemical quality of surface waters and ground waters related to hydrogeologic and cultural controls.
- \*524. (Mat.Sc. 524) VIBRATIONAL SPECTRA OF MATERIALS AND MINERALS (2) Infrared and Raman spectroscopy of solid materials with applications to crystal chemistry, materials characterization, and glass research. Prerequisites: Phys. 412, 471. *White*
- \*525. ELECTRON PROPERTIES OF MINERALS (2) Application of spectroscopy to mineralogy, crystal field, EPR, NMR, Mossbauer spectra. Application to order-disorder, element distribution, mineral stability. Prerequisites: Phys. 412, 471. *White*
526. PROBLEM SOLVING IN GEOSCIENCE (3) Multivariate statistical analysis, decision making, operations research, and systems analysis in geoscience.
- \*527. MINERALOGY I — SILICATES (3) Detailed study of the crystal structures and crystal chemistry of the silicate minerals. *Smith*
- \*528. MINERALOGY II — NONSILICATES (3) Detailed study of the crystal structures and crystal chemistry of the nonsilicate minerals. *Smith*
- \*531. (Mat.Sc. 531) TRANSMISSION ELECTRON MICROSCOPY (2) Discussion of electron image contrast theory as a tool for study of atomic substructures in the materials and mineral sciences. Prerequisite: Min. (Mat.Sc.) 411B. *Thrower*
- \*532. (Mat.Sc. 532) STRUCTURE ANALYSIS (2) Crystal structure determination methods; space groups, structure factors, heavy atoms and isomorphous replacement, Fourier synthesis, Patterson maps, inequalities, refinement techniques. Prerequisite: Geosc. (Mat.Sc.) 408. *Smith*

\*Offered alternate years.

- \*533. (Mat.Sc. 533) SINGLE CRYSTAL METHODS (2) Experimental techniques in crystal structure determination: crystal selection, space group determination, measurement of intensities, analysis of data. Prerequisite: Geosc. (Mat.Sc.) 408. *Ryba*
- \*534. (Mat.Sc. 534) DIFFRACTION BY CRYSTALS (2) Interaction of radiation with matter: coherent and incoherent scattering, extinction, fluorescence, polarization. Prerequisite: Geosc. (Mat.Sc.) 408. *McKinstry*
- \*535. (Mat.Sc. 535) GEOMETRICAL CRYSTALLOGRAPHY (3) Derivation of lattices, types, point groups, and space groups, with applications. *Smith*
- \*538. (Mat.Sc. 538) ELECTRON BEAM ANALYSIS OF SOLIDS VIA X-RAY AND ELECTRON EMISSION (3) Theory of phenomena occurring in electron-bombarded solids and their applications to analysis of solids.
- 542. ELEMENT DISTRIBUTION IN THE EARTH (3) Principles and data from studies of phase equilibria, petrology and crystal structure as related to distribution of elements in minerals, rocks, and the earth.
- 550. IGNEOUS PETROLOGY (2-3) Magmatic processes and their expression in the mineralogy, major and trace element chemistry, and isotopic composition of igneous rocks. Prerequisite: Geosc. 432. *Thornton*
- 551. PETROGENESIS (2-3) Application of theory and experimental results to the origin of igneous rocks. Prerequisites: G.M. 520, 521. *Burnham*
- 560. KINETICS IN GEOLOGICAL PROCESSES (3) General development of the kinetic theory needed in geosciences and related fields with applications to current problems. Prerequisites: Chem. 451, G.M. 521.
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)

## GEOLOGY (GEOL)

DAVID P. GOLD, *In Charge of Graduate Programs in Geology*  
 303 Deike Building  
 814-865-3934

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Cuffey, Davis, Gold, Guber, Parizek, Schmalz, Scholten, Spackman, Traverse, Voight, Williams, and Wright.

*Graduate Faculty:* Associate Members Gardner and Slingerland.

Programs are offered in stratigraphy, paleontology, sedimentation, paleobotany, palynology, regional and structural geology, geomorphology, ground water geology, engineering geology, marine geology and chemical oceanography, coal geology, coal petrology, and geology of metallic and nonmetallic deposits. The foreign language requirement for the Ph.D. degree may be satisfied by elementary competence in two languages other than English or by comprehensive competence in one.

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\*Offered alternate years.



**GEOLOGY (GEOL)**

502. (G.M. 502) CARBONATES IN THE MARINE ENVIRONMENT (3) Ancient carbonate rocks and recent carbonate sediments, with emphasis on modern field and laboratory methods and a multidisciplinary approach. *Schmalz*

503. PALEONTOLOGY (3-6 per term, maximum of 9) Morphology of animal groups significant for their fossils; nature of species and faunal zones. Seminars may be arranged for studies of special fossil groups, microfossils, paleoecology. *Cuffey*

504. HISTORY AND FOUNDATIONS OF GEOLOGY (2-4) Theoretical aspects of geology: spatio-temporal organization of matter, dynamic processes, sequential development; basic patterns and history of scientific thought. *Williams*

505. QUANTITATIVE PHYSICAL SEDIMENTOLOGY (3) Principles of fluid mechanics and mathematical modeling; their use in describing sediment transport, sedimentary structure, and sedimentary environments. Prerequisite: Geosc. 330. *Slingerland*

506. SEDIMENTS OF THE WORLD (2-3 per term, maximum of 6) Evolution of sediments from Archean to recent; relationship of sedimentation to geotectonism; kratonic and geosynclinal sediments; cyclicity. Prerequisites: Min. 512, 514. *Scholten and Williams*

508. CLASTIC DEPOSITIONAL ENVIRONMENTS (3) Readings, group discussions, and field work on processes and sedimentary responses of common rock-forming environments. Prerequisite: Geosc. 439. *Slingerland*

509. (Mn.Ec. 509) GEOLOGY AND ECONOMICS OF THE CONSTRUCTION MATERIALS (3) Occurrence, origin, and marketing of the mineral materials used by the construction industry. Economic and geologic evaluation of actual deposits. *Schenck and Wright*

510. (Mn.Ec. 510) GEOLOGY AND ECONOMICS OF THE INDUSTRIAL MINERALS (3) Occurrence, origin, and marketing of the industrial minerals and evaluation of deposits. Chemical and ceramic raw materials emphasized. *Schenck and Wright*

511. ORE DEPOSITS: PRINCIPLES (3-6) Geological and geochemical processes controlling ore deposition; genetic classification of ore deposits. Prerequisite: Geosc. 451. *Staff*

512. ORE DEPOSITS: TYPES (1-6) Geologic history and field examination of selected ore bodies; forming media; causes, sequences, and loci of emplacement; wall rock alteration; secondary enrichment. Prerequisite: Geol. 511. *Staff*

524. COAL PETROLOGY (1-6) Microscopy, source materials, coalification, constitution, classification of peats, lignites, bituminous coal, anthracite. *Davis*

526. (Biol. 526) PROBLEMS IN PALYNOLOGY (1-6) Individual research projects in various aspects of palynology, especially palynostratigraphy and paleoecological palynology. Prerequisite: Biol. 423. *Traverse*

545. GLACIAL GEOLOGY (3) Glaciers: their characteristics, causes, deposits, landforms, effects in periglacial regions. *Parizek*

546. PRINCIPLES OF PHOTOGEOLOGY (3) Use of aerial photographs and mosaics in structural, geomorphic, and rock distribution studies and in compilation of maps. Prerequisites: Geosc. 462, 465. *Gold*

551. DYNAMIC STRUCTURAL GEOLOGY AND GEOTECTONICS (3-6) Phenomena of fracturing, faulting, folding; stress and (finite) strain analysis, physical and analytical models; deformational environments; tectogenesis and orogenesis. *Scholten and Wright*

555. ADVANCED STRUCTURE AND PETROFABRICS (1-3) Macroscopic and mesoscopic recognition, measurement, and interpretation of small-scale rock structures and mineral orientation patterns in deformed rocks. *Gold*

562. FLUVIAL GEOMORPHOLOGY (3) Process-oriented analysis of the variables of the fluvial system, emphasizing man's interaction. *Gardner*

- 571. FIELD PROBLEMS IN APPALACHIAN GEOLOGY (2) Geologic history of the central Appalachians as deduced from field studies. *Slingerland*
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)

## GEOPHYSICS (GPHYS)

SHELTON S. ALEXANDER, *In Charge of Graduate Programs in Geophysics*  
 403 Deike Building  
 814-865-2622

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Alexander, Graham, Greenfield, Howell, and Lavin.

*Graduate Faculty:* Associate Members Langston and Martin.

Students may specialize in seismology, physical properties of rocks, geophysical surveying, geomagnetism, paleomagnetism, geoelectricity, gravity, wave propagation, time-series analysis, space applications of geophysics, tectonics, earth physics, and planetary sciences.

For admission an applicant is generally expected to have had mathematics through differential equations; a standard introductory course each in physics, chemistry, and earth sciences; and at least 16 credits of intermediate-level work in any one or a combination of these subjects. Students may be accepted with a previous degree in geophysics, physics, mathematics, engineering, earth sciences, or a closely allied field. There is no foreign language requirement for advanced degrees in geophysics.

## GEOPHYSICS (GPHYS)

- 502. SEISMIC INSTRUMENTS (3) Characteristics and design of seismometers and seismic recorders.
- 504. COMMUNICATION THEORY FOR GEOPHYSICISTS (3) Basic theory of random processes leading to, and including, optimum filters; geophysical applications to gravity and seismic data analysis.
- 506. MATERIAL PROPERTIES AND THE CONSTITUTION OF EARTH (3) Application of the properties of materials to the composition and physical state of earth's crust, mantle, and core.
- 507. SEISMOLOGY (3 per unit)
  - Unit A.* Basic theory; seismic methods for inferring structure of planetary interiors; observational techniques; seismic event location, magnitude, and damage potential.
  - Unit B.* Advanced wave propagation theory; mathematical representation of seismic sources; inversion theory; computational methods.
- 508. TECTONICS (3) Seminar in the cause and nature of the principal deformations of the earth.
- 512. GRAVITY AND MAGNETICS (2) Advanced applied methods; application of filter theory and wavenumber domain analysis to data enhancement and interpretation. Prerequisite: Geosc. 487.
- 513. ELECTRICAL AND ELECTROMAGNETIC METHODS (2) Advanced applied techniques; theory and procedures for determining subsurface electrical conductivity.
- 514. SEISMIC METHODS (2) Advanced applied seismic techniques; application of linear system analysis to seismic reflection interpretation problems. Prerequisite: Geosc. 487.
- 515. ADVANCES IN EXPLORATION GEOPHYSICS (2) Special topics and new developments in exploration geophysics.
- 517. COMPUTATIONAL METHODS IN GEOPHYSICS (3) Practical methods of modeling geophysical phenomena for geologic structures; data analysis techniques; systematic inversion of geophysical data; special mathematical approximations.



521. THERMAL STATE OF THE EARTH (2) Methods and instrumentation of geothermal measurements; geothermal observations; development of the theory of the thermal state of the earth.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

NOTE: *See the Geosciences (Geosc.) listing for 400-level Geophysics courses. Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in geophysical studies are listed under Mineralogy.*

## GERMAN (GER)

ERNST SCHÜRER, *Head of the Department*  
S-323 Burrowes Building  
814-865-5481

*Degrees Conferred:* Ph.D., M.A., M.Ed.

*Graduate Faculty:* Senior Members Ebbinghaus, Kopp, Preisner, and Schürer.

*Graduate Faculty:* Associate Members Browning, Keune, Martin, Strasser, and Ziegler.

There is opportunity for major emphasis upon literature, philology, or the teaching of German. The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of two foreign languages.

Students may qualify for the M.A. and M.Ed. degrees either by writing a thesis — which is recommended if a student wishes to be considered for Ph.D. candidacy — or by submitting an essay to the department and taking additional 500-level German courses in lieu of 6 credits of thesis research.

Minimum qualifications for admission include 30 undergraduate credits in German beyond the intermediate level; provision is made, however, for admission with limited deficiencies. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

## GERMAN (GER)

401. ADVANCED COMPOSITION (3)

411. THE TEACHING OF GERMAN (3)

412. STRUCTURAL ANALYSIS OF MODERN GERMAN (3)

430. HISTORY OF THE GERMAN LANGUAGE (3)

440. GERMAN STUDIES (3)

443. (C.Lit. 443) LITERARY RELATIONS OF GERMANY WITH ENGLAND AND AMERICA (3-9)

445. THE VIKINGS (3)

450. MEDIEVAL GERMAN LITERATURE I (3)

451. MEDIEVAL GERMAN LITERATURE II (3)

452. LITERATURE OF THE RENAISSANCE (3)

460. LITERATURE OF THE BAROQUE (3)

461. LITERATURE OF THE ENLIGHTENMENT (3)

462. LITERATURE OF THE LATE EIGHTEENTH CENTURY (3)

470. GOETHE (3)

471. SCHILLER (3)

472. ROMANTICISM (3)

480. REALISM (3)

481. EARLY TWENTIETH CENTURY (3)

482. RECENT GERMAN LITERATURE (3)

496. INDEPENDENT STUDIES (1-12)

\*1G. ELEMENTARY GERMAN FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees.

\*2G. ELEMENTARY GERMAN FOR GRADUATE STUDENTS (3) Continuation of Ger. 1G with opportunity for reading in special fields.

500. BIBLIOGRAPHY AND RESEARCH TECHNIQUES (3) Introduction to tools and methods of research, designed for students preparing for independent investigation of problems in German literature and language.

520. INTRODUCTION TO MIDDLE HIGH GERMAN (3) Descriptive and historical grammar; readings in simple Middle High German texts.

521. READINGS IN MIDDLE HIGH GERMAN (3) Intensive reading in Middle High German literature, especially of the *Blütezeit*. Prerequisite: Ger. 520.

522. OLD HIGH GERMAN (3) Essentials of grammar with special treatment of the High German sound shift and of ablaut and umlaut; reading of works written before 1100 A.D.

523. GOTHIC (3) Introduction to historical and comparative Germanic grammar; emphasis on the Gothic language and texts. Suitable for advanced students in English.

525. OLD ICELANDIC (3) Introduction to Old Icelandic grammar; readings in Old Icelandic prose. Suitable for advanced students in English.

531. SEMINAR IN MEDIEVAL GERMAN LANGUAGES AND LITERATURES (3-6)

541. SEMINAR IN THE LITERATURE OF THE REFORMATION AND BAROQUE (3-6)

551. SEMINAR IN THE LITERATURE OF THE ENLIGHTENMENT AND THE AGE OF GOETHE AND SCHILLER (3-6)

561. SEMINAR IN POST-IDEALISTIC LITERATURE (3-6)

571. SEMINAR IN MODERN GERMAN LITERATURE (3-6)

581. SEMINAR IN LITERARY GENRES (3-12) Special studies in the German lyric, drama, short story, and novel.

591. SEMINAR IN GERMAN LITERARY CRITICISM (3)

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

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\*No graduate credit is given for this course.



## HEALTH EDUCATION (HL ED)

RICHARD W. ST. PIERRE, *Chairman of the Department*  
19 White Building  
814-863-0435

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Senior Members Hunt, Mendez, Shute, St. Pierre, and Wickersham.

*Graduate Faculty:* Associate Members Alles, Eck, Eddy, and Powell.

Health education is a profession which complements physical education and other health-related fields such as medicine, health administration, and public health. Students may emphasize either school or community health education, and choose from a wide variety of interdisciplinary course offerings in health and related fields. The M.S. and Ph.D. degrees are academic degrees with a strong emphasis on research and the scientific and theoretical principles underlying effective health education. The M.Ed. and D.Ed. degrees are professional degrees emphasizing applied research on the problems of supervision, administration, and teaching. A nonthesis option is available for the M.Ed. degree. All programs of study require research experience to enable the student to analyze problems, assess information, draw logical conclusions, and apply research findings.

A junior-senior grade-point average of 3.00 (B) is required for admission into the master's program. A doctoral applicant is expected to have at least a 3.30 (B+) academic average for completed master's work and at least one year of full-time professional experience in health education or a related field. All applicants are further evaluated on the basis of related course work, academic achievements, work experience, technical writing ability, letters of recommendation, and the Graduate Record Examination. All students must demonstrate proficiency in the use of the English language. In addition, the communications and foreign language requirement for the Ph.D. may be satisfied in one of two methods: (1) by demonstrating intermediate knowledge of one foreign language and the selection of courses from appropriate communication areas; or (2) by selecting designated courses from areas including research design, statistics, and computer applications. Exceptions to admissions requirements may be made for students with special backgrounds, abilities, and interests.

## HEALTH EDUCATION (HL ED)

- 405. PREVENTION AND CARE OF ATHLETIC INJURIES (3)
- 408. INJURY CONTROL (3)
- 421. INTEGRATING HEALTH EDUCATION INTO THE SCHOOL PROGRAM, K-12 (3)
- 432. SAFETY EDUCATION (3)
- 433. PRINCIPLES AND METHODS OF TEACHING SAFETY EDUCATION (3)
- 443. ALCOHOL EDUCATION (3)
- 446. HUMAN SEXUALITY AS A HEALTH CONCERN (3)
- 456. ADVANCED TECHNIQUES IN SCHOOL COMMUNITY HEALTH EDUCATION (3)
- 457. CONSUMER HEALTH EDUCATION (3)
- 495. HEALTH EDUCATION PRACTICUM (3-10)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

511. (Anthy. 511) HEALTH IMPLICATIONS IN THE GROWTH AND DEVELOPMENT OF SCHOOL CHILDREN (3) Child growth and development emphasis for teachers; medical inspection and examination; preschool program; early habit formations; behavior problems; cooperation of parents, teachers, and children. Prerequisite: Hl.Ed. 215.

513. (Anthy. 513) HEALTH IMPLICATIONS IN MATURITY AND AGING (3) Changes in the human body in maturity and aging. Theories and mechanisms of physiologic aging with implications for health education. Prerequisite: Hl.Ed. 511.

521. PROBLEMS IN SCHOOL HEALTH ADMINISTRATION (3) Critical concerns in the development and

coordination of curriculum, policies, and evaluation of health education and services in school systems. Prerequisite: HI.Ed. 456.

530. (Ph.Ed. 530, Rc.Pk. 530) **RESEARCH TECHNIQUES IN HEALTH AND PHYSICAL EDUCATION AND RECREATION (3)** Research techniques, including methods, research design, techniques for data collection, as applied to relevant problems in the health education field.

552. **CURRENT HEALTH EDUCATION ISSUES (3)** Analysis of scientific and political foundations of current issues within health education tasks, with emphasis on research and action implications.

## HIGHER EDUCATION (HI ED)

ROBERT E. SWEITZER, *In Charge of Graduate Programs in Higher Education*  
328 Pond Laboratory  
814-863-2690

*Degrees Conferred:* D.Ed., M.Ed.

*Graduate Faculty:* Senior Members Eddy, Flexner, Godbey, Lindsay, Martorana, Moore, Mortimer, Sweitzer, and Toombs.

*Graduate Faculty:* Associate Member Chait.

The graduate program in the higher education major has as its goal the preparation of individuals who will pursue careers as administrators, faculty, or researchers in the nation's colleges and universities and in a variety of public and private agencies and associations. With emphasis on the systematic study of higher education, the program builds on the scholarly and scientific disciplines offered throughout the University and applies these studies to the professional functions and responsibilities which its graduates will assume.

With mounting awareness of the need for educational reforms and for improved teaching, other departments throughout the University encourage their graduate students to pursue a minor in higher education. The higher education faculty cooperates in this program — which is administered through the students' major departments — by offering a number of courses and seminars designed to promote understanding of the faculty member's instructional and professional role.

The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Applicants with a junior-senior average of 3.00, a graduate average of 3.50, and a standardized test score comparable to a 60 on the Miller Analogies Test (MAT) are usually admitted to the D.Ed. program. Applicants with a junior-senior average of 2.70, a graduate average of 3.20, and a MAT score of 50, and with special backgrounds, abilities, and interests will be considered for admission. Some outstanding students may be admitted to the doctoral program with only the baccalaureate degree, but they will earn the master's degree *en route*. For information about special requirements in the higher education major, write: Higher Education Program, The Pennsylvania State University, 328 Pond Laboratory, University Park, PA 16802.

## HIGHER EDUCATION (HI ED)

460. (Ed.Adm. 460) **INTRODUCTION TO ADULT EDUCATION (3)**

545. **HIGHER EDUCATION IN THE UNITED STATES (2-3)** A basis for all courses in higher education. Current issues are analyzed and trends of the future anticipated.

546. **COLLEGE TEACHING (2-3)** Principles involved in teaching at the college level; effective use of teaching aids; criteria used in evaluation.

547. **INTERNSHIP IN HIGHER EDUCATION (1-9)** Supervised experience in administrative offices, in research, on instructional teams, and in college teaching.

548. **CURRICULUMS IN HIGHER EDUCATION (2-3)** Various types of curriculums and philosophies



underlying them; ways in which curriculums are developed; elective versus required courses; evaluation of achievement.

549. **COMMUNITY JUNIOR COLLEGE AND THE TECHNICAL INSTITUTE (2-3)** Distinctive contributions to meeting the need for postsecondary education; development, functions, curriculum and instruction, government, administration, and finance.

550. **THE PROFESSIONS AND THE EDUCATION OF TEACHERS (3)** The nature of a profession and dimensions of professional education in the United States are explored. Trends and issues examined.

552. **ADMINISTRATION IN HIGHER EDUCATION (2-3)** Philosophy of administration; principles of scientific management and their application in colleges and universities; case studies of administrative problems. Prerequisite: courses or experience in higher education.

554. **THE HISTORY OF AMERICAN HIGHER EDUCATION (3)** An examination of the development of American higher education against the background of influential social, political, economic, and intellectual issues.

556. **COLLEGE STUDENTS (3)** Characteristics of college students; changes during college years; educational challenges and responses. Prerequisite: Hi.Ed. 545 or Psy. 426 or I.F.S. 435.

575. (Ed.Adm. 575) **ADMINISTRATION OF ADULT EDUCATION (3)** The organization of a program of adult education; its legal status, finances, selection of teachers, learning personnel, housing, and other administrative problems connected with adult education. Prerequisite: Ed.Adm. 480 or teaching or administrative or supervisory experience.

596. **INDIVIDUAL STUDIES (1-6)**

597. **SPECIAL TOPICS (1-6)**

## HISTORY (HIST)

GERALD G. EGGERT, *Head of the Department*  
601 Liberal Arts Tower  
814-865-1367

*Degrees Conferred:* Ph.D., D.Ed., M.A., M.Ed.

*Graduate Faculty:* Senior Members Ameringer, Borza, Brown, Duiker, Eggert, Enteen, Frantz, Hassler, Maddox, Murray, Silverman, Sun, and Utechin.

*Graduate Faculty:* Associate Members Garner, Goldschmidt, Green, Griffith, Harvey, Knight, Linker, Meier, Spielvogel, Stebbins, and Sweeney.

Graduate work is offered in the following areas of history: ancient, medieval, Europe since 1500, Great Britain and the British Empire, Russia and Eastern Europe, the Middle East, the Far East, the United States, and Latin America. These areas are subdivided into chronological, national, and topical fields.

The candidate for the M.A. or M.Ed. degree selects one of the above areas for the master's examination. Some courses are required in an area in history other than the examination area and in a cognate field or archival option. (The cognate field for an M.Ed. candidate must be in education.) With the consent of the adviser, a master's candidate may substitute additional course work and a paper for a thesis.

The candidate for the doctor's degree must pass examinations in one of the above areas, in a thesis field within that same area, and in one field from a second area. The student must also pass an examination in a single cognate field, or in a study area made up of a number of academic disciplines related to the subject of the thesis. The communication and foreign language requirement for the Ph.D. may be satisfied by a reading knowledge of two foreign languages or one language and work in quantitative techniques. No foreign language is required for the D.Ed. degree, but the candidate must complete a minor in education.

The entering student should present evidence of undergraduate course work covering the history of

Europe from ancient times to the present and the history of America from its discovery to the present. Students with a 3.00 junior-senior average and better than a 3.00 average in all undergraduate history courses and appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. Each applicant must provide Graduate Record Examination scores and at least three letters of recommendation.

## HISTORY (HIST)

401. CLASSICAL CIVILIZATION (3) *Borza and Harvey*
402. THE RISE OF THE GREEK POLIS (3) *Borza*
403. ALEXANDER THE GREAT AND THE HELLENISTIC WORLD (3) *Borza*
404. THE ROMAN REPUBLIC (3) *Harvey*
405. THE PAX ROMANA (3) *Harvey*
406. THE LATER ROMAN EMPIRE (3) *Harvey*
407. EARLY MEDIEVAL SOCIETY (3) *Sweeney*
408. CHURCH AND STATE IN THE HIGH MIDDLE AGES (3) *Sweeney*
410. BYZANTINE CIVILIZATION (3)
411. HISTORY OF ENGLAND IN THE MIDDLE AGES (3) *Sweeney*
412. INTELLECTUAL HISTORY OF THE MIDDLE AGES (3) *Sweeney*
414. THE RENAISSANCE (3) *Spielvogel*
415. THE REFORMATION (3) *Spielvogel*
417. THE AGE OF ABSOLUTISM (3) *Green*
418. THE FRENCH REVOLUTION AND THE NAPOLEONIC ERA (3) *Green*
419. NINETEENTH-CENTURY EUROPE (3)
420. RECENT EUROPEAN HISTORY (3)
421. INTELLECTUAL AND CULTURAL HISTORY OF EUROPE, 1600-1800 (3) *Knight*
422. INTELLECTUAL AND CULTURAL HISTORY OF EUROPE SINCE 1800 (3) *Knight and Silverman*
423. SOCIAL AND ECONOMIC HISTORY OF EUROPE SINCE 1750 (3) *Silverman*
425. DIPLOMATIC HISTORY OF EUROPE SINCE 1870 (3)
427. GERMANY SINCE 1640 (3) *Silverman*
428. FRANCE SINCE 1610 (3) *Knight*
430. EASTERN EUROPE IN MODERN TIMES (3) *Enteen*
432. HISTORY OF RUSSIA TO 1700 (3) *Utechin*
433. IMPERIAL RUSSIA, 1700-1917 (3) *Utechin*
434. HISTORY OF THE SOVIET UNION (3) *Enteen*
436. BRITAIN UNDER THE TUDORS AND STUARTS, 1485-1688 (3) *Linker*
437. GREAT BRITAIN, 1688-1832 (3) *Linker*
438. GREAT BRITAIN SINCE 1832 (3) *Linker*
440. COLONIAL AMERICA TO 1753 (3) *Frantz*
441. REVOLUTIONARY AMERICA, 1753-1783 (3) *Frantz*
442. THE FORMATIVE PERIOD OF AMERICAN HISTORY (3) *Brown*
443. THE MIDDLE PERIOD OF AMERICAN HISTORY (3) *Brown*
444. THE UNITED STATES IN CIVIL WAR AND RECONSTRUCTION (3) *Hassler*
445. THE EMERGENCE OF MODERN AMERICA (3) *Eggert*
446. AMERICA BETWEEN THE WARS (3) *Murray*
447. RECENT AMERICAN HISTORY (3) *Murray*
449. CONSTITUTIONAL HISTORY OF THE UNITED STATES TO 1877 (3) *Stebbins*
450. CONSTITUTIONAL HISTORY OF THE UNITED STATES SINCE 1877 (3) *Stebbins*
451. HISTORY OF AMERICAN POLITICAL PARTIES (3)
452. DIPLOMATIC HISTORY OF THE UNITED STATES TO 1900 (3) *Maddox*
453. THE DIPLOMATIC HISTORY OF THE UNITED STATES SINCE 1900 (3) *Maddox*
454. AMERICAN MILITARY HISTORY (3) *Hassler*
455. AMERICAN ECONOMIC HISTORY IN THE AGRICULTURAL ERA (3)
456. AMERICAN ECONOMIC HISTORY IN THE INDUSTRIAL ERA (3) *Eggert*



457. HISTORY OF THE AMERICAN FRONTIER (3)
  458. (L.S. 458) HISTORY OF AMERICAN ORGANIZED LABOR SINCE 1877 (3) *Eggert*
  459. SOCIAL AND CULTURAL HISTORY OF THE UNITED STATES SINCE 1783 (3) *Brown*
  460. UNITED STATES FOREIGN INTELLIGENCE (3) *Ameringer*
  464. SPANISH CONQUEST OF THE NEW WORLD (3) *Garner*
  465. LATIN AMERICAN INDEPENDENCE MOVEMENTS (3) *Garner*
  467. LATIN AMERICA AND THE UNITED STATES (3) *Ameringer*
  468. MEXICO AND THE CARIBBEAN NATIONS IN THE TWENTIETH CENTURY (3) *Ameringer*
  471. HISTORY OF ARABIC CIVILIZATION, 600-1258 (3) *Goldschmidt*
  472. THE OTTOMAN EMPIRE AND OTHER MUSLIM STATES (3) *Goldschmidt*
  473. THE CONTEMPORARY MIDDLE EAST (3) *Goldschmidt*
  477. HISTORY OF CENTRAL AND EAST AFRICA (3) *Griffith*
  478. HISTORY OF WEST AFRICA (3) *Griffith*
  480. THE HISTORY OF TRADITIONAL JAPAN (3)
  481. THE HISTORY OF MODERN JAPAN (3)
  483. TRADITIONAL CHINA TO 1800 (3) *Sun*
  485. NINETEENTH-CENTURY CHINA (3) *Sun*
  486. TWENTIETH-CENTURY CHINA (3) *Duiker*
  488. TWENTIETH-CENTURY SOUTHEAST ASIA (3) *Duiker*
  490. (L.St. 490) ARCHIVAL MANAGEMENT (1-3)
  496. INDEPENDENT STUDIES (1-12)
  497. SPECIAL TOPICS (1-6)
  499. FOREIGN STUDY — HISTORY (1-6)
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501. HISTORICAL METHOD (3) *Utechin*
  502. HISTORIOGRAPHY (3) *Borza and Enteen*
  503. STUDIES IN GREEK HISTORY (3-6) *Borza*
  504. STUDIES IN ROMAN HISTORY (3-6) *Harvey*
  509. MEDIEVAL CIVILIZATION (3-9) *Sweeney*
  511. STUDIES IN MEDIEVAL ENGLISH HISTORY (3-6) A seminar in the political, economic, and cultural history of England in the Middle Ages.
  515. THE AGE OF THE REFORMATION (3-6) *Spielvogel*
  517. STUDIES IN EUROPEAN HISTORY, 1600-1750 (3-6) *Knight and Green*
  519. STUDIES IN EUROPEAN HISTORY, 1750-1900 (3-6) *Knight and Silverman*
  520. STUDIES IN TWENTIETH-CENTURY EUROPE (3-6) *Silverman*
  530. SEMINAR IN EASTERN EUROPEAN HISTORY (3-6) *Enteen and Utechin*
  533. STUDIES IN RUSSIAN AND SOVIET HISTORY (3-6) *Enteen and Utechin*
  537. STUDIES IN BRITISH HISTORY (3-6) *Linker*
  540. COLONIAL AND REVOLUTIONARY AMERICA (3-6) *Frantz*
  543. THE UNITED STATES, 1783-1860 (3-6)
  544. THE UNITED STATES, 1860-1877 (3-6) *Hassler*
  546. THE UNITED STATES SINCE 1919 (3-6) *Murray*
  550. STUDIES IN CONSTITUTIONAL HISTORY (3-9) A graduate seminar examining constitutional developments in their historical context through readings, class discussions, and research papers. *Stebbins*
  553. DIPLOMATIC HISTORY OF THE UNITED STATES (3-6) *Maddox*
  555. ECONOMIC HISTORY OF THE UNITED STATES (3-6) *Eggert*

- 559. CULTURAL HISTORY OF THE UNITED STATES (3-6) *Brown*
- 560. STUDIES IN PENNSYLVANIA HISTORY (3-6) *Frantz*
- 568. STUDIES IN THE HISTORY OF THE CARIBBEAN AREA (3 per term, maximum of 6) *Ameringer*
- 569. SEMINAR IN LATIN-AMERICAN HISTORY (3-6) *Ameringer*
- 573. STUDIES IN MIDDLE EASTERN HISTORY (3-6) *Goldschmidt*
- 583. STUDIES IN ASIAN HISTORY (3-9) *Sun and Duiker*
- 591. ARCHIVES PRACTICUM (3-6) Training and supervised work experience in archival activities — Option A: Archival Management; Option B: Oral History. Prerequisite: Hist. (L.St.) 490.
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## HOME ECONOMICS EDUCATION (HE ED)

TWYLA M. SHEAR, *In Charge of Graduate Programs in Home Economics Education*  
 212 Rackley Building  
 814-865-5441

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Senior Members Murray, Ray, Shear, and Weis.

*Graduate Faculty:* Associate Member Thal.

Research and graduate courses may be chosen to give emphasis to special areas of interest in home economics education, such as curriculum development; evaluation; teaching at the elementary, secondary, adult, or higher education levels; supervision; administration in colleges; or research.

Students who have majored as undergraduates in some aspect of home economics and who have achieved a grade-point average of at least 2.50 in their junior and senior years will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests. Students wishing to be admitted to the doctoral programs must have completed a master's degree and will be admitted subject to limitations of program resources. New admissions are accepted any term. There is no foreign language requirement for degrees in the program.

## HOME ECONOMICS EDUCATION (HE ED)

- 406 AUDIO-VISUAL METHODS FOR HOME ECONOMICS (1-4)
- 427. TEACHING HOME ECONOMICS (3)
- 463. PRE-STUDENT-TEACHING SEMINAR (1)
- 464. POST-STUDENT-TEACHING SEMINAR (1)
- 466. STUDENT TEACHING (9)
- 477. CURRICULUM DEVELOPMENT FOR HOME ECONOMICS IN SECONDARY SCHOOLS (3)
- 478. APPRAISING STUDENT PROGRESS IN HOME ECONOMICS (3)
- 481. EMPLOYMENT PREPARATION PROGRAMS IN VOCATIONAL HOME ECONOMICS (3)
- 482. POSTSECONDARY, ADULT, AND CONTINUING EDUCATION PROGRAMS IN HOME ECONOMICS (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

502. HOME ECONOMICS INSTRUCTION AT THE COLLEGE LEVEL (3) Teaching techniques suitable for college instruction in home economics; for prospective home economics college teachers.



503. HOME ECONOMICS TEACHER EDUCATION (3) Organization of college programs of teacher education; use of resources; records; field services; recruitment and selection of personnel. Prerequisite: two years' experience in teaching home economics.
504. EDUCATIONAL ISSUES AND HOME ECONOMICS (3) Contemporary issues in education and their relationship to the teaching of home economics. Prerequisite: teaching experience.
510. EDUCATIONAL LEADERSHIP IN HOME ECONOMICS (2-6) Principles of educational leadership for home economists preparing for administration; supervision of city and state programs; supervision of student teachers. Prerequisites: graduation from a four-year teacher education major and two years' teaching experience in home economics.
511. INTERNSHIP IN HOME ECONOMICS SUPERVISION AND ADMINISTRATION (2-8) Opportunity to understudy an educational leader in student teacher supervision, state supervision, department or college administration, or regional consultation. Prerequisite: H.E.Ed. 510.
518. EVALUATION OF HOME ECONOMICS PROGRAMS (3) Methods of evaluating progress toward goals in home economics education and use of findings in program planning and revision.
521. HOME ECONOMICS EDUCATION SEMINAR (2-3) Selected topics and recent developments in home economics education. Conferences and guidance relative to individual research problems.
577. CURRICULA IN HOME ECONOMICS (3) Development of curricula in home economics. Prerequisite: H.E.Ed. 477.
596. INDIVIDUAL STUDIES (1-6)
597. SPECIAL TOPICS (1-6)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## HORTICULTURE (HORT)

FRANCIS H. WITHAM, *Head of the Department*  
103 Tyson Building  
814-865-2571

*Degrees Conferred:* Ph.D., M.S., M.Agr.

*Graduate Faculty:* Senior Members Beelman, Bergman, Craig, Grun, Heuser, Mastalerz, Ritter, Shannon, Smith, Stinson, Tukey, White, and Witham.

*Graduate Faculty:* Associate Members Arteca, Beattie, Cole, Daniels, Haeseler, Haramaki, Holcomb, and Kuhns.

Students may specialize in several phases of production, plant genetics and breeding, soils and plant nutrition, horticultural physiology, post-harvest physiology, plant propagation, and microclimatology. Students wishing additional credits in the commodity areas of floriculture, olericulture, ornamental horticulture, and pomology, or in the areas of specialization listed above, should register for Hort. 596.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by one of four options: (1) comprehensive competence in one language, (2) reading examination or two-course sequence in two languages, (3) reading examination or two-course sequence in one language plus 6 credits in other communication skills, or (4) 6 credits in each of two areas of communication skills.

Prerequisites for admission vary according to the area of specialization, but basic courses in physical sciences, mathematics, biological sciences, communication skills, and social sciences and humanities are required. Students who lack prerequisite courses may be admitted but are required to fulfill deficiencies without degree credit.

Students with a 2.75 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students.

## HORTICULTURE (HORT)

- 401. PLANT PROPAGATION (3) *Haramaki*
  - 402. PLANT NUTRITION (3) *Bergman*
  - 403. HORTICULTURE PLANTS AND THEIR ENVIRONMENT (3) *Mastalerz*
  - 405. SENIOR SEMINAR IN HORTICULTURE (1-2)
  - 407. PLANT BREEDING (3) *Garwood*
  - 412. POST-HARVEST PHYSIOLOGY (3)
  - 420. CHEMICAL GROWTH REGULATORS FOR HORTICULTURAL CROP PRODUCTION (3)
  - 421. PLANT TISSUE CULTURE (3)
  - 431. SMALL FRUIT CULTURE (3) *Daniels*
  - 432. DECIDUOUS TREE FRUITS (3) *Tukey*
  - 433. VEGETABLE CROP PRODUCTION (3) *Daniels*
  - 434. NURSERY CROP PRODUCTION (3) *Beattie*
  - 435. GREENHOUSE CROP PRODUCTION (3) *Holcomb*
  - 444. ADVANCED PLANT BREEDING (3-6) *Craig*
  - 451. FLOWER STORE MANAGEMENT (4) *Wolnick*
  - 452. GARDEN CENTER MANAGEMENT (3) *Wolnick*
  - 453. FLOWER CROP PRODUCTION AND MANAGEMENT (3) *Holcomb*
  - 496. INDEPENDENT STUDIES (1-12)
  - 497. SPECIAL TOPICS (1-6)
- 
- 506. NUTRITION OF HORTICULTURAL CROPS (2-4) Principles, applications, and interpretations of diagnostic methods for determining fertilizer requirements of horticultural crops. *Smith*
  - 512. PRINCIPLES OF FRUIT AND VEGETABLE STORAGE (2-4) Principles involved in the maturation, storage, and senescence of fruits and vegetables, and their application.
  - 514. PROPAGATION AND IMPROVEMENT OF HORTICULTURE PLANTS (1-6) Biological factors affecting sexual and asexual propagation of plants; techniques in plant improvement; maintenance of propagation material. *Heuser*
  - 524. EXPERIMENTAL PROCEDURES IN HORTICULTURAL RESEARCH (3) *Craig*
  - 590. COLLOQUIUM (1-3)
  - 596. INDIVIDUAL STUDIES (1-6)
  - 597. SPECIAL TOPICS (1-6)
  - 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## HUMAN DEVELOPMENT AND FAMILY STUDIES (HD FS)

ROBERT L. BURGESS, *In Charge of Graduate Programs in Human Development and Family Studies*  
S-137 Henderson Human Development Building  
814-863-0241

*Degrees Conferred:* Ph.D., M.S., M.Ed.

*Graduate Faculty:* Senior Members Britton, Burgess, Danish, D'Augelli, de Lissovoy, Deutsch, Ford, Garbarino, Gottesman, B. Guernsey, L. Guernsey, Gunter, Hultsch, Huston, Lerner, McClearn, Nesselroade, Peters, Safilios-Rothschild, Spanier, Urban, Vondracek, Willis, and Wohlwill.

*Graduate Faculty:* Associate Members Anderson, Belsky, Garduque, Gentry, Getz, Gindes, Goldberg, Hagestad, Hornblum, Lago, Madle, McHale, Nelson, Nowak, Seward, Smyer, and Treat.

This interdisciplinary program is one of the graduate programs of the College of Human Development. It is administered through the program in individual and family studies. Human development and family studies focuses on the developmental study of individuals, small groups, and families for the pur-



poses of expanding basic knowledge and professional application. The perspective encompasses the individual life span, from infancy and childhood through later maturity and old age, as well as the full cycle of the family. For both individual and family, the perspective includes variations in functioning patterns and the use of resources; the impact of diverse social, economic, and cultural contexts upon behavior; conditions which promote adaptive individual, group, and family development; and the creation of techniques of accomplishing human development. Emphasis is upon the integration of knowledge from various fields for understanding and developing skills for careers in research and scholarship, teaching, program planning and evaluation, and other professional services. The faculty includes persons primarily in the behavioral and social sciences particularly committed to research and application in these multi- and interdisciplinary areas.

The student's program is expected to include work assuring both breadth in the major field and depth within one of three program areas: family development, human development intervention, or individual development. Further specialization is possible in adult development and aging, child and adolescent development, cognitive development and functioning, early childhood services, family economics and management, family relationships, integrative theories of human development, interpersonal relationships, methods for studying change, and social-emotional development and change.

Infant and early childhood laboratories are operated as part of the teaching and research program. Each unit has observational facilities and rooms for study of individual and group behavior of children and adults. The Individual and Family Consultation Center provides facilities for the development and evaluation of educational programs for remediation of individual and family problems by professional and paraprofessional persons. The Institute for the Study of Human Development and the Gerontology Center provide opportunities for participation in research and evaluation projects. Additional resources are available in other parts of the University.

A research and evaluation methodology core, required of all students, may be satisfied by selections from a variety of courses across the campus. Use may be made also of courses in other parts of the college and University to build substantive competence in the program. The communication and foreign language requirement for the Ph.D. degree may be satisfied by options selected from designated areas including, but not restricted to, foreign languages. A minor or general studies group outside the major is required of all doctoral students.

Entering students should have at least 6 credits in the biological and physical sciences; 12 in the social sciences and, depending upon proposed area of emphasis, basic courses in sociology, psychology, and economics; and 6 in developmental and family studies. Students not meeting these requirements may be admitted with limited deficiencies to be made up concurrently with their graduate work.

Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission, which, with rare exception, will be for fall term only. Early application is required, and a special application to HDFS must be completed; additional information may be obtained from the professor in charge. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. The Graduate Record Examination is required of all applicants.

## **INDIVIDUAL AND FAMILY STUDIES (I F S)**

- 410: COMMUNITIES AND FAMILIES (3)
- 411. THE HELPING RELATIONSHIP (3)
- 412. ADULT-CHILD RELATIONSHIPS (3)
- 413. DYSFUNCTIONS IN THE DEVELOPMENTAL PROCESS (3)
- 414. RESOLVING INDIVIDUAL AND FAMILY PROBLEMS (3)
- 415. PROGRAM DEVELOPMENT IN FAMILY RELATIONSHIPS (3)
- 416. (C.S. 416) CONSUMER ROLE OF FAMILY (3)
- 418. FAMILY RELATIONSHIPS (3)
- 419. PROBLEMS OF FAMILY FINANCIAL MANAGEMENT (3)
- 420. LABORATORY IN INDIVIDUAL AND FAMILY ENHANCEMENT (3)
- 424. ECONOMIC CONDITIONS IN RELATION TO THE FAMILY (3)
- 427. CONCEPTIONS OF DEVELOPMENT (3)
- 428. INFANT DEVELOPMENT (3)
- 429. ADVANCED CHILD DEVELOPMENT (3)

430. PRACTICUM IN PRESCHOOL GROUPS (1-6)
432. DEVELOPMENTAL PROBLEMS OF NORMAL CHILDREN (3)
435. DEVELOPMENTAL TRANSITION TO ADULTHOOD (3)
442. HOME MANAGEMENT EXPERIENCE (3)
445. (Psy. 445) DEVELOPMENT THROUGHOUT ADULTHOOD (3)
450. IMPLICATIONS OF DEVELOPMENTAL THEORIES FOR CHILD PROGRAMS AND SERVICES (3)
453. CHILD PROGRAMS AND SERVICES (3)
454. (C.&S. 454) DEVELOPMENT AND ADMINISTRATION OF CHILD SERVICE PROGRAMS (3)
470. (Psy. 470) SOCIAL LEARNING FOUNDATIONS OF BEHAVIOR CHANGE (3)
477. ANALYSIS OF FAMILY PROBLEMS (2-9)
490. INTRODUCTION TO FIELD EXPERIENCE (1)
491. DESIGN OF FIELD RESEARCH PROJECTS (2)
495. ADVANCED FIELD EXPERIENCE (1-10)
496. INDEPENDENT STUDIES (1-12)
497. SPECIAL TOPICS (1-6)
  
500. NONTHESIS RESEARCH (1-9)
  
501. SEMINAR: ISSUES IN THE STUDY OF INDIVIDUAL AND FAMILY DEVELOPMENT (1-3) Reading, reports, and discussion of conceptual frameworks for multidisciplinary and developmental study of individuals and families.
  
504. PRACTICUM IN PROGRAM DEVELOPMENT FOR PRESCHOOL CHILDREN (2-6) Investigation, analysis, and report on the design, development, and evaluation of a selected program for preschool children. Prerequisites: 6 credits of individual development and I.F.S. 430, 441.
  
506. PROJECTS IN DESIGN AND EVALUATION OF PROGRAMS FOR PRESCHOOL CHILDREN (2-4) Individual projects in the design, implementation, and evaluation of different teaching approaches with varying groups of children. Prerequisites: I.F.S. 504 and 3 credits in research methods.
  
508. PARENTAL EDUCATION (1-6) Implementing educational and preventive programs for parents; discussion and evaluation of theory and techniques.
  
511. MODIFYING CONJUGAL LIFE (1-9) Conceptual foundations, research procedures, and practicum experience in teaching effective communication and problem-solving skills in the marriage relationship. Prerequisites: 6 credits in individual development or psychology and 3 credits in statistics.
  
512. FILIAL RELATIONSHIP MODIFICATION (1-9) Theory, research, and practicum in teaching parents to resolve developmental problems in their own children. Prerequisites: 6 credits in individual development or psychology and 3 credits in statistics.
  
513. GROUP PROCEDURES IN INDIVIDUAL DEVELOPMENT (1-6) Theory, research, and practicum experience in the use of group methods for promoting individual development in different age groups. Prerequisites: I.F.S. 411 and research methods or statistics.
  
515. TEACHING INDIVIDUAL DEVELOPMENT AND FAMILY STUDIES (1-6) Objectives, techniques, materials, and evaluation in teaching at the secondary and college level, and in adult and public education programs.
  
520. SEMINAR IN PRENATAL AND INFANT DEVELOPMENT (1-6) Prenatal and infant development, with emphasis on multiple determinants of early development and their relationship to later behavior. Prerequisites: 6 graduate credits in individual development, psychology, or biological science and 3 credits in statistics.
  
522. SEMINAR IN DYSFUNCTION PROCESSES IN INDIVIDUAL DEVELOPMENT (1-6) Multiple processes involved in dysfunctional development in the individual across the life-span. Prerequisite: I.F.S. 413.
  
524. THEORETIC ANALYSIS OF FAMILY ECONOMIC AND MANAGERIAL BEHAVIOR (3) Conceptual approaches and major contributions to the study of the organizational, managerial, and economic functions of the family. Prerequisite: I.F.S. 418 or 424 or 477.



525. THEORIES OF FAMILY RELATIONSHIPS (3) Assessment of the utility of major theories for empirical analysis of interpersonal interactions among family members. Prerequisite: I.F.S. 418.
529. (Psy. 529) SEMINAR IN CHILD DEVELOPMENT (1-6) Readings and reports on recent findings in child development. Prerequisites: 6 graduate credits in child development, child psychology, or educational psychology, plus 3 in statistics.
530. INDEPENDENT STUDY IN INDIVIDUAL AND FAMILY STUDIES (1-9) Problems involving individual study. Prerequisite: instructor's approval of proposed study.
532. FIELD PROJECTS IN INDIVIDUAL AND FAMILY STUDIES (1-9) Supervised research or internship in human services program. Prerequisite: instructor's approval of proposed project.
536. (Psy. 536) RESEARCH METHODS IN DEVELOPMENTAL PROCESSES (3) Methodological issues in research on varying stages of development across the individual life-span. Prerequisites: 6 credits in individual development or psychology and a course in statistics.
539. SEMINAR IN ADOLESCENT DEVELOPMENT (1-6) Cultural, psychological, and biological aspects of the developmental transition to adulthood. Prerequisites: 6 credits in individual development or psychology and 3 credits in sociology and statistics.
543. MODIFICATION OF FAMILY MANAGERIAL PRACTICES (1-3) Conceptual issues, research, and practicum experience in assisting families in the solution of financial and managerial problems.
544. SEMINAR IN DYSFUNCTIONAL PATTERNS IN FAMILY ORGANIZATION (1-6) Processes of familial dysfunction and disorganization and their explanation in economic, social-psychological, and managerial terms. Prerequisite: I.F.S. 418 or 424 or Soc. 430.
545. FAMILIES AND SOCIOECONOMIC SYSTEMS (1-6) Functional interrelationships between families and social and economic systems. Prerequisites: I.F.S. 418, 424.
546. SEMINAR IN FAMILY RELATIONSHIPS (1-9) Interpersonal interaction within family systems throughout the life cycle. Prerequisite: I.F.S. 418.
549. (Psy. 549) DEVELOPMENTAL THEORY (3) Conceptual frameworks and major contributions to the study of individual development across the life-span. Prerequisite: 6 credits at the 400 level in individual development or psychology.
550. SEMINAR IN FAMILY ECONOMICS AND MANAGEMENT (1-6) Recent developments in the study of family economic and managerial practices.
579. SEMINAR IN ADULT DEVELOPMENT AND AGING (1-9) A seminar dealing with specific topics concerning adult development and aging. Prerequisites: I.F.S. 445 and statistics.
590. COLLOQUIUM (1-3)
597. SPECIAL TOPICS (1-6)

## HUMANITIES (HUMAN)

ROBERT J. GRAHAM, *Division Head, Humanities*  
 The Capitol Campus  
 Middletown, PA 17057  
 717-948-6189

*Degree Conferred: M.A.*

*Graduate Faculty:* Senior Members Barton, Dordevic, R. Graham, T. Graham, Gross, Richman, Tischler, G. Wolf, and M. Wolf.

*Graduate Faculty:* Associate Members Churchill, Mahar, Patterson, K. Sweeney, T. Thomas, and Winston.

Defining humanities as the study of men and societies through examinations of their arts, this program aims at developing skills for the interdisciplinary study of art, music, literature, philosophy, and related

fields such as photography, film, dance, and theater. Entering students are expected to have studied in at least two of the major areas. Exceptions may be made for students with special backgrounds and abilities who are committed to attaining competence in a second area. A supervisory committee meets with each student to determine individual needs and arrange a program designed to develop skills for the formal analysis of works; for analysis based on various critical perspectives; for evaluation of works by applications of appropriate criteria; and for the perception of relationships between styles, media, periods, and cultures. For students who plan to teach in a junior or community college, there is also provision for an internship option following the completion of most degree requirements.

A series of six 500-level courses is designed to help a student develop a number of the program skills. In addition, the adviser may suggest enrollment in certain 400-level courses or in independent studies with qualified faculty. The degree program requires completion of 18 credits at the 500 level.

To qualify for the M.A. in humanities, the student must demonstrate competence in applying the methods of humanistic inquiry to a relevant subject area. Course work and independent study will help in the development of the appropriate skills and the acquisition of necessary knowledge, but the degree is not awarded in recognition of a set total number of course credits having been compiled; the degree testifies that the recipient has cultivated the necessary skills of analysis and synthesis and has successfully completed a scholarly or creative master's production.

Ordinarily, a full-time student can expect to complete the program in four terms, a part-time student in six to nine terms.

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

This program is available only at the Capitol Campus.

## HUMANITIES (HUMAN)

500. RESEARCH METHODS (3) Study of the methods and materials of scholarship, compilation of bibliographies, writing of scholarly papers, and proper documentation.

502. PERENNIAL ISSUES IN THE HUMANITIES (3) Recurrent issues viewed in terms of their significance to the artist, historian, and the philosopher.

503. INTERRELATIONS IN THE HUMANITIES (3) An interdisciplinary study of the interdependence of aesthetic values in various art forms as they exist in cultural settings. Prerequisite: Human. 500.

520. STUDIES IN STYLE (3) Study of prominent stylistic patterns, evaluating the essence of a style, and the varied responses of the artist and philosopher within a pattern.

525. STUDIES IN AESTHETICS (3) Study of certain techniques in the arts that presuppose certain aesthetic concepts and certain ideas that demand parallel form.

580. MASTER'S PRODUCTION (1-6) An original scholarly master's paper or creative production initiated by the student, supervised by an appropriate professor, and judged by a committee.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

Additional courses may be taken from the following list and at the 400- or 500-level in related fields with the concurrence of the student's adviser.

AM.ST. 445. AMERICAN PHILOSOPHY

AM.ST. 452. THE AMERICAN RENAISSANCE

AM.ST. 459. AMERICA'S COMING OF AGE 1914-1939

AM.ST. 460. AMERICAN ART AND ARCHITECTURE

AM.ST. 461. AMERICAN ART AND ARCHITECTURE OF THE NINETEENTH CENTURY

AM.ST. 463. AMERICAN MUSIC

ART 415. STUDIO ART



- ART 420. CRITICAL APPROACHES TO ART  
 ART 427. MASTERS OF ART  
 ART 440. TOPICS IN ART  
 HUMAN. 405. THE STUDY OF INTELLECTUAL AND CULTURAL HISTORY  
 HUMAN. 408. COMPARATIVE STUDY OF RELIGIOUS LITERATURE  
 HUMAN. 409. MYTH AND CHILDREN'S LITERATURE  
 HUMAN. 410. RELIGION AND LITERATURE  
 HUMAN. 430. PHILOSOPHY AND LITERATURE  
 HUMAN. 441. MYTH, SYMBOL, AND RITUAL  
 HUMAN. 453. LITERATURE AND SOCIETY  
 HUMAN. 460. THEMATIC STUDIES  
 HUMAN. 461. SELECTED PERIODS IN THE HUMANITIES  
 LIT. 427. MASTERS OF LITERATURE  
 LIT. 440. FORM AND FUNCTION  
 LIT. 450. CULTURAL PATTERNS IN LITERATURE  
 LIT. 460. LITERARY PERIODS  
 LIT. 461. STUDIES IN LITERARY STYLE  
 MUSIC 427. MASTERS OF MUSIC  
 MUSIC 440. FORMS IN MUSIC  
 MUSIC 460. STUDIES IN MUSICAL STYLE  
 O.S. 410. CHINESE PHILOSOPHY AND WESTERN THOUGHT  
 O.S. 455. ORIENTAL CULTURE  
 PHIL. 415. AESTHETICS  
 PHIL. 431. PHILOSOPHICAL PERSPECTIVES  
 PHIL. 440. READING OF AN INDIVIDUAL PHILOSOPHER  
 PHIL. 445. SOCIAL-POLITICAL PHILOSOPHIES  
 PHIL. 447. PHILOSOPHICAL PERIODS  
 PHIL. 490. PHILOSOPHICAL TOPICS  
 THEA. 406. STUDIES IN THEATRE  
 ED. 550. INTERNSHIP IN JUNIOR COLLEGE

## INDUSTRIAL ENGINEERING (I E)

WILLIAM E. BILES, *Head of the Department of Industrial and Management Systems Engineering*  
 207 Hammond Building  
 814-865-7601

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Senior Members Biles, Draper, Enscoe, Guild, Ham, Ignizio, Raphael, and Rosenshine.

*Graduate Faculty:* Associate Members Chandra, Freark, Freivalds, Fugelso, Goodrich, Kozik, Pegden, Thuring, and Zindler.

Graduate study and research are conducted in operations research-management science, production engineering, process design, systems engineering, and human engineering.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by an intermediate knowledge of one foreign language (Russian, German, French, or Japanese).

Graduates in industrial engineering, other engineering curriculums, and mathematics who present a 2.50 junior-senior average will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

Students in this program may elect the dual-title degree program option in operations research for the Ph.D. and M.S. degrees (see p. 249).

The M.Eng. degree is also offered at the Radnor Center for Graduate Studies.

## INDUSTRIAL ENGINEERING (I E)

- 400. ENGINEERING FOR PRODUCTION (3)
  - 401. WORK MEASUREMENT APPLICATIONS (3)
  - 402. ENGINEERING ECONOMY (3)
  - 403. ENGINEERING ECONOMY AND STATISTICS (3)
  - 404. MANAGEMENT SCIENCE (3)
  - 405. LINEAR PROGRAMMING (3)
  - 406. DESIGN OF PRODUCTION AND DISTRIBUTION SYSTEMS (3)
  - 407. QUANTITATIVE METHODS FOR OPERATIONS RESEARCH (3)
  - 408. HUMAN FACTORS ENGINEERING (3)
  - 414. MATERIALS JOINING PROCESSES AND PRINCIPLES (3)
  - 423. QUALITY CONTROL AND RELIABILITY (3)
  - 424. PROBLEMS IN PERSONNEL MANAGEMENT (3)
  - 425. INTRODUCTION TO OPERATIONS RESEARCH (3)
  - 426. INDUSTRIAL AUTOMATION (3)
  - 427. SOLIDIFICATION OF CASTINGS (3)
  - 428. FOUNDRY ENGINEERING (3)
  - 432. INTRODUCTION TO RELIABILITY ENGINEERING (1-3)
  - 438. METAL CUTTING PRINCIPLES AND PRACTICE (3)
  - 439. ENGINEERING SYSTEMS OPTIMIZATION (3)
  - 450. MANUFACTURING SYSTEMS ENGINEERING (3)
  - 451. NUMERICAL CONTROL (3)
  - 496. INDEPENDENT STUDIES (1-12)
  - 497. SPECIAL TOPICS (1-6)
- 
- 501. MANUFACTURING METHODS (2-8) Special projects including investigation, experimentation, design, and research of one or more special types of manufacture.
  - 503. INDUSTRIAL RELATIONS (1-6) Study of human problems related to labor unions, hierarchy, specialization; analysis of organizational structure, policies, decision criteria, and communication systems.
  - 506. ADVANCED WORK DESIGN AND MEASUREMENT (3-9) Methods of research in motion and time study; critical analysis of current literature.
  - 507. OPERATIONS RESEARCH: SCHEDULING MODELS (3) Scheduling models with simultaneous job arrival and probabilistic job arrival, network scheduling, and scheduling simulation techniques. Prerequisite: I.E. 425.
  - 508. OPERATIONS RESEARCH: INVENTORY MODELS (3) A study of inventory theory, deterministic models, probabilistic models, multiproduct models in both the single and multiperiod modes. Prerequisite: I.E. 425.
  - 509. OPERATIONS RESEARCH: WAITING LINE MODELS (3) Waiting line models including models with infinite queues, finite queues, single and multiple servers under various priorities and disciplines. Prerequisite: I.E. 425.
  - 510. MATHEMATICAL PROGRAMMING (3) Study of advanced topics in linear programming including duality, decomposition, sensitivity analysis, parametric programming, and selected topics in mathematical programming. Prerequisite: I.E. 405.
  - 511. EXPERIMENTAL DESIGN IN ENGINEERING (3) Statistical design and analysis of experiments in engineering; experimental models and experimental designs using the analysis of variance. Prerequisite: I.E. 323.
  - 512. GRAPH THEORY AND NETWORKS IN MANAGEMENT SCIENCE (3) Prerequisite: I.E. 425.
  - 513. REAL TIME DATA PROCESSING FOR ENGINEERING SYSTEMS (3) Random access computers and communication components for real time systems; engineering systems simulation on digital computers. Prerequisite: Cmp.Sc. 102 or 410.



515. **COMPLEX LINEAR FLOW MODELS (3)** Application of complex linear flow models in engineering and management science, including static and dynamic system simulations. Prerequisite: I.E. 405.

516. **APPLIED STOCHASTIC PROCESSES I (3)** Prerequisite: Stat. (Math.) 427.

518. **PLASTIC DEFORMATION PROCESSES (3)** Study of the principles, theories, technology, design, and application of plastic deformation processes to shape metals. Prerequisite: undergraduate engineering degree.

519. **DYNAMIC PROGRAMMING (3)** Study of the concepts underlying model-building and optimization of dynamic systems with application to engineering, economic, and environmental systems. Prerequisites: I.E. 405 or Q.B.A. 451; Stat. 418.

520. **GOAL PROGRAMMING (3)** Study of concepts and methods in analysis of systems involving multiple objectives with applications to engineering, economic, and environmental systems. Prerequisite: I.E. 405 or Q.B.A. 451.

521. **ENGINEERING SYSTEMS OPTIMIZATION (3)** Fundamental theory of optimization, including classical optimization, search methods, functional optimization; with engineering applications as industrial, mechanical, and chemical processes. Prerequisites: Math. 260 and FORTRAN programming ability.

522. **INDUSTRIAL SYSTEMS SIMULATION (3)** Study of discrete-event, network, and continuous simulation of industrial and manufacturing systems using the SLAM/GASP-IV languages; statistical techniques in simulation methodology. Prerequisites: I.E. 322 and FORTRAN programming ability.

528. **METAL CUTTING THEORY (3)** Study of the theory of metal cutting, contemporary and future problems of metal removal processes; critical analysis of current literature. Prerequisite: I.E. 438.

532. **RELIABILITY ENGINEERING (3)** Mathematical definition of concepts in reliability engineering; methods of system reliability calculation; reliability modeling, estimation, and acceptance testing procedures. Prerequisite: I.E. 323 or Stat. 302 or 3 credits in probability and statistics with a prerequisite of calculus.

538. **EXPERIMENTAL INVESTIGATIONS IN MATERIALS PROCESSING (3)** Experimental investigation on selected subjects in processing involving instrumentation, methods, and analysis. Prerequisite: I.E. 528.

550. **MANUFACTURING SYSTEMS (3)** Fundamental theory for analyzing manufacturing systems including structural analysis, optimization and economics of manufacturing systems, automated and computer-aided manufacturing. Prerequisite: I.E. 450.

551. **COMPUTER CONTROL OF MANUFACTURING SYSTEMS (3)** Analysis of microprocessor-controlled servo loops, adaptive control, stochastic methods in control; analysis of NC machines, robots, and their controllers. Prerequisites: I.E. 407; Engr. 100 or M.E. 455 or E.E. 428.

596. **INDIVIDUAL STUDIES (1-6)**

597. **SPECIAL TOPICS (1-6)**

## JOURNALISM (JOURN)

ROBERT O. BLANCHARD, *In Charge of the Graduate Program in Journalism*  
215 Carnegie Building  
814-865-6597

*Degree Conferred:* M.A.

*Graduate Faculty:* Senior Members Blanchard and Smith.

*Graduate Faculty:* Associate Members Berner, Dulaney, Farson, Froke, Goodwin, Nichols, Norris, Pfaff, and Rippey.

The one-year program is intended to serve two kinds of students: those who enter with several years of media work experience who are interested in improving their job marketability or in broadening the range of their professional abilities, and those with little or no media experience who are interested in preparing for a career in journalism. Experienced persons will be required to earn from 30 to 33 credits in prescribed course work and electives. Those without experience will take 33 to 36 credits of course work and electives. Experienced persons will have more latitude in course selection than those without experience. In individual cases, it may be possible for a candidate to take up to 9 credits of work outside the School of Journalism. In all cases, the program must be substantially completed in twelve months.

Students with a 3.00 junior-senior average are eligible for admission. Those with lower averages who have significant professional experience or other unusual qualifications also will be considered. Two letters of recommendation are required. They should be from persons closely familiar with the applicant's professional background and competencies. The Graduate School requires all applicants to submit copies of their Graduate Record Examination scores. Applicants must submit an autobiographical statement of about 1,000 words indicating the nature of the applicant's interest in journalism or mass communications, reasons for wanting to do graduate work, and aspirations for the future.

### JOURNALISM (JOURN)

- 401. MASS MEDIA IN HISTORY (3)
- 403. LAW OF MASS COMMUNICATIONS (3)
- 405. POLITICAL ECONOMY OF COMMUNICATIONS (3)
- 407. ADVERTISING IN CONTEMPORARY SOCIETY (3)
- 409. NEWS MEDIA ETHICS (3)
- 411. CULTURAL ASPECTS OF THE MASS MEDIA (3)
- 413. THE MASS MEDIA AND THE PUBLIC (3)
- 415. CURRENT ISSUES IN ADVERTISING (3)
- 416. (Engl. 416) SCIENCE WRITING (3-6)
- 417. ADVERTISING AND CONSUMERISM (3)
- 419. (Sp.Com. 419) COMPARATIVE BROADCASTING SYSTEMS (3)
- 421. PUBLIC AFFAIRS REPORTING (3)
- 423. REPORTING OF CONTEMPORARY ISSUES (3)
- 425. NEWS EDITING AND EVALUATION (3)
- 426. REPORTING BUSINESS AND ECONOMIC NEWS (3)
- 427. MAGAZINE JOURNALISM (3)
- 429. EDITORIAL INTERPRETATION (3)
- 436. (Soc. 436) SOCIOLOGY OF OPINION FORMATION (3)
- 441. ADVERTISING COMMUNICATIONS PROBLEMS (3)
- 443. ADVERTISING MEDIA PLANNING (3)
- 445. ADVERTISING CAMPAIGNS (3)
- 451. PUBLIC RELATIONS (3)
- 452. PUBLIC RELATIONS MEDIA AND METHODS (3)
- 453. PUBLIC RELATIONS PROBLEMS (3)
- 461. PHOTOGRAPHY FOR THE MASS MEDIA (3)
- 473. INTERNATIONAL MASS COMMUNICATIONS (3)
- 475. MASS COMMUNICATIONS RESEARCH (3)
- 477. JOURNALISM IN THE SCHOOLS (3-6)
- 492. PUBLIC AFFAIRS BROADCASTING (3)
- 495. INTERNSHIP (1-9)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
- 499. (Sp.Com. 499) FOREIGN STUDY — MASS COMMUNICATIONS (1-9)
  
- 504. SEMINAR IN THE HISTORY OF MASS COMMUNICATION (3)
- 505. INTERNATIONAL COMMUNICATION PROBLEMS (3) Legal and communications problems of the international flow of news and opinion; international press codes.



506. INTRODUCTION TO MASS COMMUNICATIONS RESEARCH (3) The scientific method; survey of basic concepts of theoretical and empirical research; variety of methodology; criteria for adequate research.
508. THE LITERATURE OF JOURNALISM (3)
511. MASS COMMUNICATIONS RESEARCH METHODS II (3) Problems of bibliographical research; evaluation of sources and materials in mass communications history, biography, structure, ethics, and other areas. Prerequisite: Journ. 506.
513. CONSTITUTIONAL PROBLEMS OF THE NEWS MEDIA (3) Problems involving conflict between guarantees of press freedom in the First and Fourteenth Amendments and rights and privileges of others.
521. NEWS MEDIA AND PUBLIC OPINION (3) Problems in the function, techniques, and responsibilities of press, radio, and television in forming and interpreting opinion.
524. GOVERNMENT AND MASS COMMUNICATIONS (3) Problems of freedom of information; governmental efforts to control mass communication agencies; government news coverage; public information agencies. *Smith*
540. SEMINAR IN ADVERTISING PROBLEMS (3) *Norris*
585. COMPARATIVE THEORIES OF PRESS SYSTEMS (3) Institutional structure and normative functions of press systems in modern societies, as shaped by prevailing world view and social organization. *Norris*
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-6)
597. SPECIAL TOPICS (1-6)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## LABORATORY ANIMAL MEDICINE (L A M)

C. MAX LANG, *Chairman of the Department of Comparative Medicine*  
The Milton S. Hershey Medical Center  
Hershey, PA 17033  
717-534-8460

*Degree Conferred:* M.S.

*Graduate Faculty:* Senior Members Bullock and Lang.

*Graduate Faculty:* Associate Members Hughes, Singh, and White.

The department offers a postdoctoral program for veterinarians leading to the Master of Science degree with a major in laboratory animal medicine. Laboratory animal medicine is a specialty of veterinary medicine that is concerned with the biology of laboratory animals and their comparative relationships to man. Postdoctoral training in this discipline provides a broad, basic foundation upon which the individual can build a career in teaching and research in laboratory animal medicine and/or in the professional direction of research animal facilities. The program has a strong research-oriented base with emphasis on comparative medicine and pathology.

The program requires two years for completion. Basically, the first year consists of formal course work, while the second year is devoted mainly to research and the development of clinical skills and techniques. A student must have earned a minimum of 12 credits in a major subject, 6 credits in a minor subject, and 6 credits of thesis research in order to receive the graduate degree. Approved minors have been established in anatomy, behavioral science, biological chemistry, microbiology, pathology, pharmacology, and physiology.

Students with a 3.00 junior-senior average, with a doctor of veterinary medicine degree, and with ap-

propriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

This program is offered only at The Milton S. Hershey Medical Center.

## COMPARATIVE MEDICINE (C MED)

501. BIOLOGY AND CARE OF LABORATORY ANIMALS (2) Presentation of the anatomic and physiologic characteristics of the commonly used laboratory animal species and their relation to biomedical research.

503. LABORATORY ANIMAL GENETICS (2) Genetic principles applied to laboratory animals used for investigations of diseases that may be controlled or influenced by genetic factors.

505. LABORATORY ANIMAL ZOOSES (2) Experimentally induced, spontaneous, and infectious diseases transmissible between man and animals, with special emphasis on etiology, differential diagnosis, and control.

507. TECHNIQUES OF LABORATORY ANIMAL EXPERIMENTATION (2) Techniques of drug administration, infusion, and collection of body fluids and materials; gnotobiology; use of radioisotopes and bioinstrumentation.

510. ANIMAL PHYSIOLOGICAL SURGERY (3) Selected operative procedures, demonstrating principles of physiology with modern biomedical instrumentation, will be followed through the postoperative period.

515. EXPERIMENTAL SURGERY OF LABORATORY ANIMALS (3) Surgical techniques, including nephrectomy and Goldblatt clamp, bladder and gastric pouches, bile duct cannulation, intraventricular operation, cardiac and cerebrovascular catheterization.

530. DISEASES OF LABORATORY ANIMALS I (3) Physiological and pathological expressions of both infectious and metabolic-degenerative diseases of rodents, with emphasis on diagnostic and control methods.

531. DISEASES OF LABORATORY ANIMALS II (3) Physiological and pathological expressions of both infectious and metabolic-degenerative diseases of nonhuman primates and other species of animals.

535. COMPARATIVE PATHOLOGY (3) Comparative pathologic characteristics of infectious and metabolic disease of animals and man.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

## LINGUISTICS (LING)

PHILIP BALDI, *In Charge of Graduate Programs in Linguistics*  
310 Burrowes Building  
814-865-6873

*Degree Conferred:* M.A.

*Graduate Faculty:* Senior Members Baldi, Brault, Brubaker, Dalbor, Ebbinghaus, Magner, Martin, Morrill, Palermo, Schmalstieg, and Sturcken.

*Graduate Faculty:* Associate Members Boisset, Buckalew, and Zawadzki.

A student majoring in linguistics may specialize in one of several flexible interdisciplinary graduate programs. The M.A. degree program includes general courses in historical linguistics, generative phonology and syntax, psycholinguistics, and acoustic phonetics. A candidate will also select, with the



help of the graduate adviser, a coherent set of electives in a specialized area which may be a language or a related field, such as applied linguistics, psycholinguistics, or communication disorders. An acceptable thesis or paper must be submitted and a written comprehensive examination passed.

The minimum requirement for admission to an advanced degree program will normally be a B.A. degree in linguistics or an equivalent in any of the interdisciplinary subjects recognized as a specialized area.

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

## LINGUISTICS (LING)

- 400. INTRODUCTION TO TRANSFORMATIONAL GRAMMAR (3)
- 401. INTRODUCTION TO LINGUISTIC THEORIES (3)
- 402. HISTORICAL LINGUISTICS (3)
- 404. GENERATIVE PHONOLOGY (3)
- 413. (Sp.Com. 413) EXPERIMENTAL LINGUISTICS (3)
- 415. CONTRASTIVE ANALYSIS (3)
- 420. (Psy. 420) ADVANCED PSYCHOLINGUISTICS (3)
- 448. LANGUAGE VARIATION (3)
- 449. PROBLEMS IN TRANSFORMATIONAL SEMANTICS (3)
- 461. (Latin 461) HISTORY OF THE LATIN LANGUAGE (3)
- 496. INDEPENDENT STUDIES (1-12)
  
- 500. GENERATIVE LINGUISTICS (3) Types of grammatical rules and their interrelations; algorithm for assigning structural descriptions; evaluation procedure for selecting best compatible grammar.
- 503. GENERATIVE SYNTAX (3) Grammatical rules specifying well-formed strings; conditions on analyzability and assigning of structural descriptions; deviation from well-formedness. Prerequisite: Ling. 400.
- 504. GENERATIVE PHONOLOGY (3) Distinctive feature theory in the generative framework; articulatory and acoustic correlates; nonphonemic features. Prerequisite: Ling. 400.
- 505. SEMINAR IN HISTORICAL LINGUISTICS (3) Detailed study of some problem of historical linguistics, e.g., the laryngeal theory, Indo-European ablaut, etc. Prerequisite: one course in historical linguistics.
- 517. (Cm.Dis. 517) APPLICATIONS OF LINGUISTICS TO COMMUNICATION DISORDERS (1) Application of linguistic theory to the understanding of communication disorders, with clinical implications for speech and language therapy. Prerequisites: 12 credits in communication disorders, psychology, linguistics, or phonetics.
- 520. (Psy. 520) SEMINAR IN PSYCHOLINGUISTICS (3) Consideration of theoretical and research issues relevant to psychological aspects of language sounds, syntax and semantics, and other cognitive support.
- 595. SEMINAR IN INTERDISCIPLINARY LINGUISTICS (3-12) Methods of research. Common and individual investigations in interdisciplinary fields of linguistics in consultation with one or more interdisciplinary instructors. Prerequisite: Ling. 400.
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## MAN-ENVIRONMENT RELATIONS (M E R)

STUART H. MANN, *Program Head*  
S-126 Henderson Human Development Building  
814-865-1467

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Senior Members Everett, Lawton, Mann, Patterson, Studer, Vallance, and Wohlwill.

*Graduate Faculty:* Associate Members Cohn, Griffin, Loukissas, van Vliet, and Weisman.

The program in man-environment relations has two degree programs, one leading to the Ph.D. degree in man-environment relations and the other to the D.Ed. degree in food service management.

The objective of the Ph.D. degree program in man-environment relations is to seek, through a broad-based analysis of complex environmental problems, an integrated understanding of man-environment systems, and to develop appropriate methods to plan and manage these systems. The multidisciplinary program is concerned with the analysis of the effects of the physical environment upon human psychological, social, and biological functioning, and with the development of methods for organizing planned systems in response to social and behavioral goals. The research and instructional activities in the program focus on (1) the relation of behavior to characteristics of environmental settings such as schools, housing and recreational facilities, and urban neighborhoods and communities; (2) environment-behavior relations in such functional systems as health care and transportation; and (3) the effects of planned intervention in the environment on individual and social behavior. These problems are considered with reference to the population in general, as well as special groups such as children, the aged, and the handicapped.

The program trains scientists for problem-oriented research dealing with environment-behavior systems. Instruction emphasizes the application of disciplinary information to problems arising from people interacting with the physical environment. Doctoral students in the program are expected to acquire skills in a wide range of research and intervention methods and in techniques and theoretical perspectives of man-environment relations, and to develop the competency to generate applied research contributing to a body of knowledge of benefit to the design fields and social science alike.

Providing the appropriate multidisciplinary perspective are faculty with backgrounds in such fields as architecture, architectural engineering, city and regional planning, operations research, urban design, social and experimental psychology, organizational behavior, and sociology. In addition to these full-time faculty, the program has available the resources of a group of adjunct faculty in diverse fields related to man-environment relations.

Recent graduates have taken positions with governmental and private research organizations dealing with environmental facilities, services, and problems and with colleges and universities with departments of architecture, planning, psychology, and environmental and urban studies.

Relevant undergraduate preparation may be in the design and planning professions, environmental and urban studies, and other programs in the physical, social, or behavioral sciences appropriate to the study of man-environment systems. Students with a 3.00 junior-senior grade-point average will be considered for admission. Exceptions to the minimum 3.00 average may be made for students with special backgrounds, abilities, and interests.

The program offers an M.S. degree for those entering the program without a master's degree but does not consider it a terminal degree.

Students in the Ph.D. program may elect the dual-title degree program in operations research for the Ph.D. and M.S. degrees (see page p. 249).

The D.Ed. degree program in food service and housing administration equips its students to meet the critical need for educators qualified to staff programs and serve as department heads in hospitality education. The program has been designed to develop professional leadership in the field of hospitality education through a combination of study, research, and teaching experience. The applicant should possess a master's degree in food service and housing administration or a similar academic course of study. The course work leading toward the degree can be arranged to reflect the individual student's interests and prior educational experience. Although the course work can be drawn from appropriate disciplines throughout the University, the research emphasis focuses predominantly on food service administration and travel and lodging management.



**MAN-ENVIRONMENT RELATIONS (M E R)**

- 414. PLANNING COMMUNITY ENVIRONMENTS (3)
- 435. (Psy. 435) ENVIRONMENTAL STIMULATION AND BEHAVIOR (3)
- 442. ANALYTIC METHODS IN MAN-ENVIRONMENT RELATIONS II (3)
- 447. (Soc. 447) ENVIRONMENTAL SOCIOLOGY (3)
- 452. MAN-ENVIRONMENT RELATIONS LABORATORY II (3 per term, maximum of 6)
- 453. MAN-ENVIRONMENT RELATIONS LABORATORY III (3 per term, maximum of 6)
- 471. HOUSING SPACE RELATED TO LIVING PATTERNS (3)
- 472. HOUSING PROBLEMS AND POLICIES (3)
- 480. METHODS FOR THE DESIGN OF ENVIRONMENT-BEHAVIOR SYSTEMS (3)
- 481. MANAGEMENT METHODS FOR ENVIRONMENT-BEHAVIOR SYSTEMS (3)
- 482. PLANNING METHODS FOR ENVIRONMENT-BEHAVIOR SYSTEMS (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 500. NONTHESIS RESEARCH (1-6)
- 501. PROBLEMS IN MAN-ENVIRONMENT RELATIONS (1-9) Individual directed study, investigation, and practice in selected aspects of man-environment relations.
- 502. SEMINAR IN MAN-ENVIRONMENT RELATIONS (1-9)
- 503. RESEARCH METHODS AND EVALUATION IN MAN-ENVIRONMENT RELATIONS (1-9)
- 505. ENVIRONMENTAL-BEHAVIORAL PROGRAMMING, DESIGN, AND MANAGEMENT (3) Applications of findings in the behavioral sciences to environmental design and management strategies; empirical, theoretical, and methodological issues.
- 506. THEORY AND APPLICATIONS IN ENVIRONMENT-BEHAVIOR RELATIONS (4) An overview of the field of man-environment relations with emphasis on current research perspectives and their application to real-world problems.
- 507. FIELD RESEARCH METHODS IN MAN-ENVIRONMENT RELATIONS (4) A survey of methods, problems of research design, and data collection in field research in man-environment relations.
- 508. PROBLEM-SOLVING METHODS IN MAN-ENVIRONMENT RELATIONS (4) Study of problem-solving methods for planning and policy development in environment-behavior systems, with laboratory and field applications.
- 510. PSYCHOLOGICAL FOUNDATIONS OF THE STUDY OF ENVIRONMENT-BEHAVIOR RELATIONS (3) Seminar relating the psychology of perception, cognition, motivation, personality, attitude formation, and psychological stress to aspects of the physical environment.
- 512. BEHAVIOR ANALYSIS OF ENVIRONMENTAL PROBLEMS (3) Analysis of behaviors contributing to environmental dysfunction. Behavior change strategies are proposed to deal with such problem areas as transportation, pollution, overpopulation.
- 515. ENVIRONMENTAL SYSTEMS THEORY (3) An in-depth review of those elements of general systems theory relevant to the analysis and organization of man-environment settings.
- 516. QUANTITATIVE METHODS IN ENVIRONMENTAL MANAGEMENT (3) The use of operations research and systems analysis in the modeling of man-environment systems. Prerequisite: M.E.R. 515.
- 520. RECENT DEVELOPMENTS IN TEXTILES (3) Developments in fibers, yarns, fabrics, finishes; effects on use and care; discussions and reports based on current literature.
- 534. (Stat. 534) DYNAMIC PROGRAMMING (3) The study of the concepts underlying model-building and optimization of dynamic systems; applications to engineering, economic, and environmental systems. Prerequisites: Stat. 418; I.E. 405 or Q.B.A. 451.
- 597. SPECIAL TOPICS (1-6)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## FOOD SERVICE AND HOUSING ADMINISTRATION (FS HA)

- 402. FOOD SERVICE AND HOUSING LAYOUT AND DESIGN (3)
- 410. ADVANCED QUANTITY FOOD PRODUCTION (3)
- 412. FOOD AND BEVERAGE OPERATIONS (3)
- 435. FINANCIAL MANAGEMENT IN HOSPITALITY INDUSTRIES (3)
- 442. HOSPITALITY MERCHANDISING (3)
- 461. PERSONNEL FUNCTIONS IN FOOD SERVICE AND HOUSING ADMINISTRATION (3)
- 470. PROBLEMS IN FOOD SERVICE AND HOUSING ADMINISTRATION (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

## MATHEMATICS (MATH)

CHRISTINE W. AYOUB, *In Charge of Graduate Programs in Mathematics*  
 229 McAllister Building  
 814-865-7527

*Degrees Conferred:* Ph.D., M.A., M.Ed.

*Graduate Faculty:* Senior Members Andrews, Armentrout, Axt, C. Ayoub, R. Ayoub, Brownawell, Deutsch, Glasner, Hahn, Herman, Hunter, James, Jech, Kanwal, Krall, Lallement, Maserick, Morris, Olson, Parsons, Rung, Simpson, Stevens, Ware, Waterhouse, Wells, and Yood.

*Graduate Faculty:* Associate Members J. Anderson, Bressoud, Buhler, Chen, P. Chowla, Formanek, Fulton, Hager, Huff, Li, Mansfield, Mitchell, McCammon, Mills, Sibley, Staffeldt, Vaserstein, and Weisfeiler.

Graduate courses in all the principal branches of mathematics are offered regularly each year. The department is prepared to direct research in a variety of fields, including various branches of analysis, algebra, topology, number theory, applied analysis, and mathematical logic and foundations.

To be admitted to the Ph.D. or M.A. program without undergraduate deficiency, an applicant should have completed at least 18 credits in mathematics at the advanced undergraduate level (400 series or their equivalents). The undergraduate student is urged to take at least 6 credits in foundations of analysis (Math. 420-421), 6 in modern algebra (Math. 480-481), and 3 in topology (Math. 429) or their equivalents. These courses are essential preparation for the graduate program, and if they are taken after admission, a maximum of 6 credits may be counted toward an advanced degree.

Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

All Ph.D. students must take qualifying examinations in three fields of mathematics. Normally these examinations are taken before the beginning of the third year of graduate study. Recommendations for advancement to Ph.D. candidacy are based on these examinations together with performance in the first two years of study. The comprehensive examination is given after approximately 60 credits are earned and after the student has passed reading examinations in two languages chosen from French, Russian, or German. The Ph.D. student is also expected to enroll in advanced seminars.

Outstanding students who do not continue in the doctoral program may petition the department for further support in order to pursue a second master's degree in another area to which mathematics is applicable.

For the M.A. degree the department offers two options: (1) the thesis option requires 12 credits of approved 500-series courses in mathematics, 6-9 credits of thesis, sufficient credits in approved 400- or 500-series courses to make a total of 30 credits, and a final oral examination based on the thesis and general course material; and (2) the nonthesis option requires 18 credits of 500-series courses in mathematics with a grade of A or B, sufficient credits in approved 400- or 500-series courses to make a total of 30 credits, and a term paper on an approved topic in mathematics. No final examination is given in this option. A student choosing the program option in operations research must complete a thesis.



To be admitted to the M.Ed. program without undergraduate deficiency, an applicant should have completed at least 15 credits in mathematics at the intermediate level beyond calculus. The M.Ed. program does not require any 500-series courses, but the student is encouraged to select some at this level. Special courses have been instituted for the training of teachers. Among these are Math. 400, 401, 416, 425-426, and 470-471. These are acceptable for the satisfaction of credit requirements only for the M.Ed. degree.

Entering graduate students in mathematics for whom English is not the first language are required to have a score of at least 550 on the TOEFL (Test of English as a Foreign Language) examination. Furthermore, the results of this examination must be received by the Department of Mathematics at least six months prior to the requested date of admission to the Graduate School.

Students in this program may elect the dual-title degree program option in operations research for the Ph.D. and M.A. degrees (see p. 249).

A brochure describing more fully the graduate program in mathematics is available from the Department of Mathematics.

## MATHEMATICS (MATH)

- 400. PROBABILITY FOR TEACHERS (3)
- 401. GEOMETRY FOR TEACHERS (3 each)
- 404. THEORY OF NUMBERS (3)
- 406. TOPICS IN THEORY OF NUMBERS (3)
- 409. (Stat. 409) INTRODUCTION TO PROBABILITY THEORY (3)
- 410. (Stat. 410) MATHEMATICAL STATISTICS I (3)
- 411. FINITE DIFFERENCES (3)
- 412. (Stat. 412) MATHEMATICAL STATISTICS II (3)
- 416. MATHEMATICAL LOGIC FOR TEACHERS (3)
- 417. (A.M. 417) TENSOR ANALYSIS (3)
- 418. (A.M. 418, Stat. 418) DISCRETE PROBABILITY THEORY (3)
- 419. (A.M. 419, Phys. 419) THEORETICAL MECHANICS (3)
- 420. INTRODUCTION TO ANALYSIS I (3)
- 421. INTRODUCTION TO ANALYSIS II (3)
- 422. ALGEBRAIC GEOMETRY (3)
- 423. METRIC DIFFERENTIAL GEOMETRY (3)
- 425-426. ANALYSIS FOR TEACHERS (3 each)
- 427. (Stat. 427) DISCRETE STOCHASTIC MODELS (3)
- 428. (Phil. 428) LOGICAL THEORY (3)
- 429. GENERAL TOPOLOGY (3)
- 430. ELEMENTARY ALGEBRAIC TOPOLOGY (3)
- 431. (A.M. 431) ORDINARY DIFFERENTIAL EQUATIONS (3)
- 432. (A.M. 432) FOURIER SERIES AND PARTIAL DIFFERENTIAL EQUATIONS (3)
- 433. (A.M. 433) OPERATIONAL MATHEMATICS (3)
- 435. AXIOMATIC SET THEORY (3)
- 441. (A.M. 441) MATRIX ALGEBRA (3)
- 451. (A.M. 451) ADVANCED CALCULUS FOR ENGINEERS I: REAL VARIABLES (3)
- 452. (A.M. 452) ADVANCED CALCULUS FOR ENGINEERS II: COMPLEX ANALYSIS (3)
- 453. (Cmp.Sc. 453) NUMERICAL COMPUTATIONS (3)
- 454. (Cmp.Sc. 454) MATRIX COMPUTATIONS (3)
- 456. COMPUTABILITY AND UNSOLVABILITY (3)
- 461. (A.M. 461, Phys. 461) THEORETICAL MECHANICS (3)
- 465. CLASSICAL ANALYSIS I (3)
- 466. CLASSICAL ANALYSIS II (3)
- 470-471. ALGEBRA FOR TEACHERS (3 each)
- 472. FOUNDATIONS OF GEOMETRY (3)
- 480. BASIC ABSTRACT ALGEBRA (3)
- 481. LINEAR ALGEBRA (3)
- 484. LINEAR PROGRAMS AND RELATED PROBLEMS (3)
- 485. GRAPH THEORY (3)

489. MATHEMATICS SEMINAR (1-6)

496. INDEPENDENT STUDIES (1-12)

497. SPECIAL TOPICS (1-6)

501-502. THEORY OF FUNCTIONS OF A REAL VARIABLE (3 each) Sets, metric spaces, measure and integration,  $L_p$  spaces and other function spaces, differentiation. Prerequisite: Math. 421.

504. (A.M. 504) OPTIMIZATION THEORY (3) Least squares problems, min-max game theory, global theory of constrained optimization, iterative methods of optimization. Prerequisite: Math. 420.

505. (A.M. 505) INTEGRAL EQUATIONS (3) Fredholm and Volterra equations, and applications. Prerequisite: Math. (A.M.) 431 or 432 or Math. 420.

506. (A.M. 506) DISTRIBUTIONS AND GENERALIZED FUNCTIONS (3) Schwartz-Sobolev theory of distributions, tempered distributions, Fourier transforms, fundamental solutions of ordinary and partial differential equations; applications. Prerequisite: Math. (A.M.) 431 or 432 or Math. 420.

507. (A.M. 507) CALCULUS OF VARIATIONS AND OPTIMAL CONTROL (3) Classical and modern theory of the calculus of variations; problems in optimal control. Prerequisite: Math. (A.M.) 431 or 432 or Math. 420.

508-509. COMPLEX ANALYSIS (3 each) Analytic and meromorphic functions; Riemann's mapping theorem. Prerequisite: Math. 421.

511. LINEAR ALGEBRA (3) Vector spaces and linear transformations, canonical representations, elementary divisors and invariant factors. Prerequisite: Math. 481 or 537.

515. (A.M. 515) PARTIAL DIFFERENTIAL EQUATIONS OF MATHEMATICAL PHYSICS (3) Methods of solution of selected elliptic, parabolic, and hyperbolic partial differential equations, with reference to physical application. Prerequisite: Math. (A.M.) 431 or 432.

516. (A.M. 516) ADVANCED PARTIAL DIFFERENTIAL EQUATIONS (3) Elliptic operators, fundamental solutions, weak and strong derivatives, Sobolev inequalities, Dirichlet problem, equations of evolution, semi-groups. Prerequisite: Math. (A.M.) 515.

517-518. (Stat. 517-518) PROBABILITY THEORY (3 each) Measure theoretic foundation of probability, distribution functions and laws, types of convergence, central limit problem, conditional probability, special topics. Prerequisites: Math. 452, 501.

520. PROJECTIVE GEOMETRY (3) General study of the subject from the synthetic and analytic standpoint. Prerequisites: Math. 472, 480.

521. ANALYTIC NUMBER THEORY I (3) Improvements of the prime number theorem,  $L$ -functions and class numbers, asymptotic and arithmetic properties of coefficients of modular forms. Prerequisites: Math. 508, 594.

522. ANALYTIC NUMBER THEORY II (3) Distribution of primes, analytic number theory in algebraic number fields, transcendental numbers, advanced theory of partitions. Prerequisite: Math. 521.

523. DIFFERENTIAL GEOMETRY (3) Manifolds-differentiable structures, tangent spaces, connections, structural equations, Riemannian geometry. Prerequisite: Math. 429.

524. ADVANCED COMPLEX ANALYSIS (3) Topics include boundary behavior of analytic functions, bounded analytic functions, conformal mapping, theory of Riemann surfaces. Prerequisite: Math. 509.

525. THEORY OF FUNCTIONS OF SEVERAL COMPLEX VARIABLES (3-6) Topics include fundamental properties of holomorphic functions, complex analytic manifolds, integral representations, Cousin problems. Prerequisite: Math. 509.

526. THEORY OF SHEAVES (3) Presheaves over topological spaces; defining sheaves two ways; Čech cohomology of presheaves; cohomology of sheaves; flasks; Lubkin's punctual cochains. Prerequisites: Math. 429; Math. 480 or 535.

527. ALGEBRAIC GEOMETRY (3) Preschemes and proschemes; products; projective finite and affine presentation maps; projective quasicoherent sheaves; cohomology of quasicoherent sheaves over affine schemes. Prerequisite: Math. 526.



528. **UNIFORM SPACES AND FUNCTION SPACES (3)** Uniform spaces, completion, compactifications, function spaces, metrization. Prerequisite: Math. 429.
- 529-530-531. **TOPOLOGY (3 each)** Topological, product, compact, metric, and connected spaces; continuous functions; separation axioms, countability conditions, combinatory topology.
532. **SET THEORY (3)** Axiomatic set theory, cardinal arithmetic, infinitary combinatorics. Constructible universe, forcing, and generic models. Consistency and independence of the continuum hypothesis. Prerequisites: Math. (Phil.) 554, Math. 556.
533. **ADVANCED SET THEORY (3)** The constructible universe, forcing, trees, infinitary combinatorics, large cardinals; applications to topology, measure theory, and projective set theory. Prerequisite: Math. 532.
- 535-536-537. **ALGEBRA (3 each)** Basic theory of semigroups and groups, rings and modules, fields, lattices.
538. **COMMUTATIVE ALGEBRA (3)** Topics selected from noetherian rings and modules, primary decompositions, Dedekind domains and ideal theory, other special types of commutative rings or fields. Prerequisite: Math. 536.
539. **RINGS (3)** Selected topics from the theory of rings. Prerequisite: Math. 536.
542. (Stat. 542) **STATISTICAL DISTRIBUTION THEORY IN SCIENTIFIC WORK: I. DISCRETE MODELS (3)** Statistical distributions arising in scientific modeling and statistical inference; structures, interrelations, characterizations, and simulation with practical examples. Prerequisite: Math. (Stat.) 410; knowledge of matrix algebra.
543. (Stat. 543) **STATISTICAL DISTRIBUTION THEORY IN SCIENTIFIC WORK: II. CONTINUOUS MODELS (3)** Statistical distributions arising in scientific modeling and statistical inference; structures, interrelations, characterizations, and simulation with practical examples. Prerequisite: Math. (Stat.) 542.
544. **APPLIED ALGEBRA I (3)** Basic algorithms of algebra, application to number theory, group theory, field theory, linear algebra, and combinatorics. Prerequisites: Math. 480, 481, and ability to use a computer.
545. **APPLIED ALGEBRA II (3)** Analysis and implementation of various algorithms used in current mathematical research. Prerequisite: Math. 544.
- 547-548-549. **LIE THEORY (2 each)** Topics selected from theory of topological semigroups, topological groups, lie groups, transformation groups. Prerequisite: Math. 531.
551. (Cmp.Sc. 551) **NUMERICAL ALGEBRA (3)** Zeros of polynomials; iterative solution of linear and nonlinear systems; sparse matrix techniques; eigenvalues and eigenvectors. Prerequisite: Cmp.Sc. 454 or Math. 441.
552. (Cmp.Sc. 552) **INTRODUCTION TO APPROXIMATION THEORY (3)** Interpolation; remainder theory; approximation of functions; error analysis; orthogonal polynomials; approximation of linear functionals; functional analysis applied to numerical analysis. Prerequisites: Math. 420 and 3 credits in computer science.
553. (Cmp.Sc. 553) **NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS (3)** Methods for initial value and boundary value problems. Stability and convergence analysis, automatic error control, and stiff systems. Prerequisites: Cmp.Sc. 453, Math. 431.
554. (Phil. 554) **LOGIC AND METAMATHEMATICS (3)** Completeness, Lowenheim-Skolem and compactness theorems. First-order arithmetic, recursiveness and the incompleteness and consistency of arithmetic. Prerequisite: Math. 428.
555. **ADVANCED RECURSION THEORY (3)** Recursively enumerable sets, degrees of unsolvability, admissible ordinals, inductive definitions, projective hierarchy, fine structure of the constructible hierarchy. Prerequisite: Cmp.Sc. 559 or Math. 556.
556. **RECURSION THEORY (3)** Recursive functions; normal form, enumeration and separation theo-

rems; partial recursive functions; recursion theorems; special recursive functions; alternate formulations; related topics. Prerequisite: Math. (Phil.) 554.

557. MODEL THEORY (3) Countable models, saturated models, categorical theories, and related topics. Prerequisites: Math. 532, 556.

560-561. (A.M. 560-561) ORDINARY DIFFERENTIAL EQUATIONS (3 each) Linear spaces and operators, existence and uniqueness of solutions, linear systems, Green's functions, eigenvalue problems—including Fourier series. Prerequisite: Math. 250 or 383 or Math. (A.M.) 431.

562. THEORY OF SPECIAL FUNCTIONS (3) Topics include asymptotic expansions; Riemann-Papperitz and Trusdell's  $F$  equations; orthogonal polynomials; generating, beta, zeta, hypergeometric, Bessel, Legendre, elliptic functions. Prerequisites: Math. 250 or 383 and either Math. 420 and 452, or Math. 508.

563. APPROXIMATION THEORY (3) Approximation in normed spaces; existence, uniqueness, characterization, computation of best approximations; error bounds; degree of approximation; approximation of linear functionals. Prerequisites: Math. 453, 501.

564. (Cmp.Sc. 564) NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS (3) Methods of parabolic, hyperbolic, and elliptic partial differential equations; finite difference and variational methods; splines, finite elements. Prerequisites: Cmp.Sc. 453, 454; A.M. 451 or Math. 405.

565. FUNCTIONAL ANALYSIS (3) Theory of Banach and Hilbert spaces, including functionals and operators, and related topics. Prerequisite: Math. 502.

566. ALGEBRAIC NUMBER THEORY I (3) Dedekind rings; cyclotomic and Kummer extensions; valuations; ramification, decomposition, inertial groups; Galois extensions; locally compact groups of number theory. Prerequisites: Math. 537, 594.

567. ALGEBRAIC NUMBER THEORY II (3) Local and global class field theory; integral quadratic forms; algebraic and arithmetic groups; algebraic function of one variable. Prerequisite: Math. 566.

568. ADVANCED ALGEBRA I (3) Noetherian and Artinian modules and rings, simple and semi-simple modules and rings, radicals. Prerequisite: Math. 537.

569. ADVANCED ALGEBRA II (3) Multilinear algebra, commutative algebra, homological algebra. Prerequisite: Math. 568.

570. SPECIAL TOPICS IN GEOMETRY (3-12)

571. SPECIAL TOPICS IN ANALYSIS (3-12)

572. SPECIAL TOPICS IN ALGEBRA (3-12)

573. SPECIAL TOPICS IN APPLIED MATHEMATICS (3-12)

574. SPECIAL TOPICS IN FOUNDATIONS OF MATHEMATICS (3-12)

575-576. MATHEMATICS SEMINAR (1-6 each) Selected topics from recent mathematical developments.

578. SPECIAL TOPICS IN TOPOLOGY (3-12)

579. (Cmp.Sc. 579) SPECIAL TOPICS IN NUMERICAL ANALYSIS (2-12)

580. SPECIAL TOPICS IN NUMBER THEORY (2-12)

581-582. GROUP THEORY I, II (3 each) Selected topics from group theory including Abelian, solvable, nilpotent, and free groups, Sylow theorems, and group extensions and representations. Prerequisite: Math. 535.

583. HOMOLOGICAL ALGEBRA (3) Modules, diagrams, functors, homology of complexes, resolutions, cohomology of groups, tensor and torsion products. Prerequisite: Math. 536.

584-585-586. ALGEBRAIC TOPOLOGY (2 each) Development of singular and Čech homology and cohomology theories; homotopy and cohomotopy theories. Prerequisite: Math. 531.

590. COLLOQUIUM (1-3)



592-593-594. **NUMBER THEORY** (3 each) Congruences, quadratic residues, arithmetical functions, Dirichlet's theorem, prime number theorem, classical multiplicative ideal theory, partitions, valuations and p-adic numbers, divisors. Prerequisite: Math. 480. Prerequisite or concurrent: Math. 508.

596. **INDIVIDUAL STUDIES** (1-6)

597. **SPECIAL TOPICS** (1-6)

602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING** (1-2)

NOTE: *Courses in Applied Mathematics, Computer Science, and Statistics are listed separately.*

## MATHEMATICS (MATH)

HELMUT E. WEBER, *In Charge of the Graduate Program in Mathematics*  
Radnor Center  
259 Radnor-Chester Road, Radnor, PA 19087  
215-293-9860

*Degree Conferred:* M.Ed.

*Graduate Faculty:* Associate Members Duncan and Llorens.

The program is offered specifically to permit teachers in the area to pursue advanced studies through evening classes while employed in teaching. Courses offered for the program are established and controlled by the resident departments at the University Park Campus.

Credit requirements may be satisfied by completing a minimum of 18 credits in approved mathematics courses, a minimum of 6 credits in approved mathematics and science courses, and a minimum of 6 credits in approved education courses. In addition, a term paper is required. All requirements must be met within six years or seven consecutive summers.

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. An applicant must have a bachelor's degree and have completed 27 credits in mathematics including at least 15 credits at the intermediate level beyond calculus. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

Further details concerning this program may be obtained by writing directly to the Radnor Center for Graduate Studies.

## MECHANICAL ENGINEERING (M E)

DONALD R. OLSON, *Head of the Department*  
207 Mechanical Engineering Building  
814-865-2519

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Senior Members Cunningham, Faeth, Heinsohn, Henderson, Henry, Kuo, Lestz, Olson, Park, Reethof, Schmidt, Shearer, Wambold, Webb, Weber, and Wolgemuth.

*Graduate Faculty:* Associate Members Archibald, Hayhoe, Huber, Hughes, Kulkarni, McDaniel, Merkle, Midha, Parke, Smith, and Turns.

Graduate programs and research facilities are available in thermodynamics and combustion, heat transfer, fluid mechanics, dynamic system analysis, mechanical design, and energy systems. Air pollution control, automotive safety, designing for noise control and for reliability also provide many research and design opportunities.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by an in-depth study of one foreign language (6 credits), by taking two or more courses (minimum of 6 credits) of a nontechnical nature in a single area of study appropriate and related to the student's career orientation, or by taking an advanced technical writing course (Engl. 418 — 4 credits) and presenting a formal proposal for thesis research (M.E. 580 — 2 credits) to the doctoral committee.

A student working toward an M.S. degree may choose one of the following options: (1) a minimum of 24 course credits plus 6 thesis credits (M.E. 600) culminating in the submission of a thesis to the Graduate School, (2) a minimum of 30 course credits plus a technical report, or (3) a minimum of 30 course credits plus submission of a Ph.D. thesis research proposal, provided the student has passed the candidacy examination.

The entering student must hold a bachelor's degree in engineering or physical science. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

## MECHANICAL ENGINEERING (M E)

- 400. HONORS THESIS (1-3)
- 403. ROCKET PROPULSION (3)
- 405. AIR POLLUTION CONTROL SYSTEMS (3)
- 409. GAS TURBINES (3)
- 410. POWER PLANTS (3)
- 411. REFRIGERATION AND AIR CONDITIONING (3)
- 412. HEAT TRANSFER (3)
- 413. INTERNAL COMBUSTION ENGINES (3)
- 414. ENGINEERING ANALYSIS OF THERMAL SYSTEMS (3)
- 415. ENGINEERING ANALYSIS FOR MECHANICAL DESIGN (3)
- 417. THEORY OF ENGINEERING INSTRUMENTS (3)
- 418. PRINCIPLES OF TURBOMACHINERY (3)
- 420. HEAT-EXCHANGER DESIGN (3)
- 421. (Aersp. 421) INTERMEDIATE VISCOUS FLOW (3)
- 440. MODELING OF DYNAMIC SYSTEMS (3)
- 450. DESIGN OF MACHINE TOOLS (3)
- 451. ADVANCED MACHINE DESIGN PROBLEMS (3)
- 452. DESIGN ANALYSIS (3)
- 454. ADVANCED MACHINE DYNAMICS (3)
- 455. AUTOMATIC CONTROL SYSTEMS (3)
- 458. NOISE CONTROL IN MACHINERY (3)
- 460. RELIABILITY CONCEPTS IN DESIGN (3)
- 470. FUNDAMENTALS OF AIR POLLUTION (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 503. THERMODYNAMIC PROCESS ANALYSIS (3) Development of equations governing separate processes in complete machines to give basic system parameters and characteristics; transient processes; irreversible effects.
- 504. ADVANCED ENGINEERING THERMODYNAMICS (3-6) Pure and applied thermodynamics including its application to advanced engineering problems; collateral reading and discussion of the classical works on the subject.
- 505. DESIGN OF AIR POLLUTION CONTROL SYSTEMS (3) Advanced principles of design drawn from



professional literature, including mechanical collectors, electrostatic precipitators, filters, scrubbers, and industrial ventilation systems. Prerequisite: M.E. 405.

512. HEAT TRANSFER — CONDUCTION (3) One- and two-dimensional conduction heat transfer for steady state and transient systems with varying boundary conditions.

513. HEAT TRANSFER — CONVECTION (3) Laminar and turbulent flow heat transfer in natural and forced convection systems.

514. HEAT TRANSFER — RADIATION (3) Thermal radiation fundamentals; specular and diffuse systems; differential and integral methods; numerical techniques; industrial applications.

515. TWO-PHASE HEAT TRANSFER (3) Heat transfer processes involving evaporation, boiling, and condensation.

516. COMBUSTION IN PROPULSION SYSTEMS (3) Theoretical formulations and methods of solution of engineering problems and physical processes in chemical propulsion systems.

519. COMPRESSIBLE FLUID FLOW (2-4) Two-dimensional subsonic flow; similarity rules; theory of characteristics; supersonic and hypersonic flows; nonsteady flow; oblique shock waves.

521. ELECTROMAGNETIC AND THERMODYNAMIC FLOW SYSTEMS (3) Thermodynamic equations for flow of reacting and nonreacting fluids in electromagnetic fields; applications to engineering problems.

522. BOUNDARY LAYER AND SEPARATED FLOWS (3) Behavior of viscous fluids, with emphasis on boundary layer and separation effects in internal flow.

540. NUMERICAL SOLUTIONS APPLIED TO HEAT TRANSFER AND FLUID MECHANICS PROBLEMS (3) Application of finite difference methods to the study of potential and viscous flows and conduction and convection heat transfer.

552. ADVANCED DYNAMICS OF MACHINES (3-6) Linear and torsional vibrations in and balancing of rotating and reciprocating machinery; exact analysis of stresses produced by these and other dynamic forces in machine parts. Prerequisites: E.Mch. 12, M.E. 54.

555. AUTOMATIC CONTROL SYSTEMS (3) Advanced problems and techniques in the design of automatic control systems with emphasis on stability, controller design, and optimum performance. Prerequisite: M.E. 455.

557. MECHANISM SYNTHESIS (3) Geometrical and algebraic methods for synthesizing planar and spatial mechanisms, dynamics of spatial mechanism.

558. FLUID CONTROL SYSTEMS (2) Modeling fluid system dynamic performance, experimental determination of the actual behavior, and comparison of predicted behavior with actual behavior. Prerequisite: M.E. 455.

562. SIMULATION OF MECHANICAL SYSTEMS (3) Introduces computational fundamentals, including digital logic; programming language, basic numerical analysis and data processing, as applied to mechanical simulation techniques. Prerequisites: M.E. 54, 66.

571. AIR POLLUTION SEMINARS (1-2) Weekly seminars featuring the contributions of many different disciplines to the solution of air pollution and other environmental problems.

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## METALLURGY (METAL)

JOHN H. HOKE, *In Charge of Graduate Programs in Metallurgy*  
209 Steidle Building  
814-865-5446

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Bitler, Hoke, Muan, Pickering, Ryba, Simkovich, and Thrower.

*Graduate Faculty:* Associate Members Osseo-Asare and Small.

This program is one of the options in which a graduate student in the Department of Materials Science and Engineering can receive an advanced degree. A student may specialize, through both course work and research, in the science and engineering aspects of chemical, physical, or mechanical metallurgy.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of one foreign language together with courses from other designated areas.

Suitable preparation for graduate study in this program may be found in one of the material sciences such as ceramic science, fuel science, metallurgy, or solid state science; in engineering fields such as chemical or mechanical engineering; in basic physical sciences such as chemistry or physics; or in earth sciences such as geochemistry and mineralogy. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

### METALLURGY (METAL)

- 400. CORROSION FORMS AND PREVENTION (3)
- 401. METALLURGICAL PROCESSES AND KINETICS (3)
- 402. CORROSION ENGINEERING (3)
- 403. PHYSICAL METALLURGY LABORATORY (1)
- 404. DESIGN OF PYROMETALLURGICAL SYSTEMS (3)
- 405. PHYSICAL METALLURGY (3)
- 406. ALLOY SYSTEMS (3)
- 407. SOLIDIFICATION PROCESSING (3)
- 408. DEFORMATIONAL PROCESSING (3)
- 410. METALLURGICAL INVESTIGATIONS AND DESIGN (1-6)
- 412. SOLID STATE METALLURGY (3)
- 414. EXTRACTIVE METALLURGY LABORATORY (1)
- 416. HYDROMETALLURGY LABORATORY (1)
- 426. (Mn.Pr. 426) HYDROMETALLURGY (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 501. METALLURGICAL PROBLEMS (1-6 per term) Independent study of special problems in metallurgy.
- 505. OXIDATION OF METALS (3) The course will cover high-temperature oxidation of metals and alloys including Wagner's theories of internal oxidation. Prerequisite: Chem. 451. *Simkovich*
- 507. (Mn.Pr. 507) HYDROMETALLURGICAL PROCESSING (3) Fundamental physico-chemical factors underlying the aqueous extraction and recovery of metals and nonmetals from ores, minerals, and scrap metal. Prerequisite: Metal. (Mn.Pr.) 426. *Osseo-Asare*
- 508. KINETICS OF PHASE TRANSFORMATIONS (3) Application of statistical mechanics and absolute rate theory to kinetics of phase transformations, including diffusion, nucleation, and growth rates. *Bitler*
- 509. INTRODUCTORY THEORETICAL PHYSICAL METALLURGY (3) Quantum mechanics and its appli-



cation to solid-state theory; introduction of Schroedinger's equation, its solutions, free-electron model, band model. *Bitler*

510. MAGNETIC AND TRANSPORT PROPERTIES OF MATERIALS (3) Treatment of the magnetic and transport properties of solids by quantum mechanics with applications to practical alloy development. Prerequisite: Metal. 509. *Bitler*

513. ADVANCED CHEMICAL METALLURGY I (3) Application of thermodynamics and kinetics to the heterogeneous metallurgical processes of oxidation, reduction, smelting, and refining. Prerequisites: Chem. 452, Metal. 301, 402, 404. *Simkovich*

514. DISLOCATION THEORY (3) Self and interaction energies of dislocations and other defect structures; dislocation motions and their relation to mechanical properties. *Bitler*

515. CORROSION OF METALS (3) Phenomena and theories of metallic corrosion; principles of alloy selection for engineering and structural uses in corrosive environments. *Pickering*

516. FLOW AND FRACTURE OF SOLIDS (3) Phenomenological and theoretical treatment of flow and fracture in solids. Prerequisite: Metal. 514.

517. METAL ELECTRODE REACTIONS (2) Evaluation of electrode reaction mechanisms at metal/water and metal/oxide/water interfaces relevant to corrosion and industrial electrolytic processes. Prerequisites: Chem. 451, 452. *Pickering*

518. HETEROGENEOUS EQUILIBRIA AT HIGH TEMPERATURES (2-3) Treatment of high-temperature equilibria in metal and oxide systems involving crystalline, liquid, and gas phases. Prerequisite: Metal. 513. *Muan*

519. ADVANCED CHEMICAL METALLURGY II (3) Application of thermodynamics and kinetics to precipitation of nonmetallic and metallic phases from liquid and solid metals at elevated temperatures. Prerequisite: Metal. 513. *Small*

520. FOUNDRY METALLURGY (3) Physical-chemical considerations of the liquid state, solidification, and the solid state as applied to casting of metals and alloys. Prerequisite: Metal. 513.

522. SOLID-PHASE REACTIONS IN METALS (3) Mechanisms and rate-determining factors in solid-phase reactions in metals; diffusion processes, nucleation theory, precipitations from solid solution, eutectoid decomposition and order-disorder phenomena. Prerequisite: Metal. 508. *Bitler*

535. (E.Mch. 535) CRYSTAL DEFECTS AND MECHANICAL RESPONSE (3) Mechanical responses of crystalline solids containing point, line, and interfacial defects; elastic and plastic responses. Prerequisite: Metal. 514 or E.Mch. 414. *Queeney*

NOTE: Courses in introductory thermodynamics and kinetics of metals, and the use of X-ray diffraction, electron microscopy, and spectroscopy in metallurgical studies are listed under Materials Science.

## METEOROLOGY (METEO)

ALFRED K. BLACKADAR, *Head of the Department*  
503 Deike Building  
814-865-0478

Degrees Conferred: Ph.D., M.S.

Graduate Faculty: Senior Members Anthes, Blackadar, Cahir, R. de Pena, Dutton, Fraser, Hosler, Panofsky, and Thomson.

Graduate Faculty: Associate Members Albrecht, Clark, Olivero, and J. Pena.

Candidates may specialize in the study of problems in either theoretical or applied meteorology including such areas as cloud physics, various phases of dynamic meteorology and geophysical fluid dynam-

ics including turbulence and atmospheric circulation, numerical modeling, macro- and microclimatology, synoptic meteorology, or meteorological instrumentation. The department also encourages interdisciplinary studies in such fields as agricultural meteorology, biometeorology, water resources, air pollution, and fluid mechanics.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of German or Russian. The thesis or paper option is available for the M.S. degree.

Requirements for admission include mathematics through differential equations and one year of college physics. Undergraduate study of meteorology is not required for admission. Special programs are available to encourage the graduate study of meteorology by all students with strong backgrounds in mathematics, physics, or engineering. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

## METEOROLOGY (METEO)

- 400. METEOROLOGY FOR TEACHERS (3)
  - 401. PHYSICAL CLIMATOLOGY FOR TEACHERS (3)
  - 404. MOTIONS OF THE ATMOSPHERE AND OCEANS (3)
  - 407. ELEMENTS OF PHYSICAL OCEANOGRAPHY (3)
  - 411. INTRODUCTORY PHYSICAL METEOROLOGY (3)
  - 418. INTRODUCTORY PHYSICS OF THE UPPER ATMOSPHERE (3)
  - 420. TROPICAL METEOROLOGY (3)
  - 430. INTRODUCTION TO SYNOPTIC METEOROLOGY LABORATORY (3)
  - 431. SYNOPTIC METEOROLOGY LABORATORY I (3)
  - 432. SYNOPTIC METEOROLOGY LABORATORY II (2-10)
  - 433. ADVANCED SYNOPTIC ANALYTICAL TECHNIQUES (3)
  - 434. APPLICATION OF METEOROLOGICAL SATELLITE DATA TO ANALYSIS AND FORECASTING (3)
  - 442. OBSERVING METEOROLOGICAL PHENOMENA (3)
  - 443. RADIATIVE TRANSFER (3)
  - 446. (Geosc. 402) NATURAL DISASTERS SEMINAR (2)
  - 450. APPLICATIONS OF STATISTICS TO METEOROLOGY (3)
  - 451. DYNAMIC METEOROLOGY I (3)
  - 452. DYNAMIC METEOROLOGY II (3)
  - 453. DYNAMIC METEOROLOGY III (3)
  - 461. THEORY OF METEOROLOGICAL INSTRUMENTS (3)
  - 472. PHYSICAL AND DYNAMIC CLIMATOLOGY (3)
  - 473. INTRODUCTION TO MICROMETEOROLOGY (3)
  - 475. ATMOSPHERIC CHEMISTRY AND PHYSICS OF CLOUDS (3)
  - 496. INDEPENDENT STUDIES (1-12)
  - 497. SPECIAL TOPICS (1-6)
- 
- 502. SELECTED TOPICS OF ADVANCED METEOROLOGY (1-3 per term) Current problems in meteorology. Prerequisite: a minimum of 15 credits in meteorology.
  - 503. ATMOSPHERIC TURBULENCE (3) Atmospheric diffusion, heat conduction, friction, and evaporation; statistical properties of turbulence.
  - 505. BIOCLIMATOLOGY (2) Climatic phenomena in their relation to life. Prerequisite: Meteo. 472.
  - 506. ADVANCED METEOROLOGICAL ANALYSIS (2-6) Physical analysis of atmospheric phenomena; synoptic analysis of weather phenomena for advanced students.
  - 507. DYNAMIC OCEANOGRAPHY (2) Physical properties of sea water; heat balance of the oceans; theory and observations of ocean currents, waves, and tides.
  - 508. PHYSICS OF THE UPPER ATMOSPHERE (2) Temperature distribution, composition, and electrical characteristics of the upper atmosphere; theories of aurora and light of the night sky.



509. **THEORETICAL CLIMATOLOGY (2)** Theory of latitudinal, annual, and diurnal temperature changes; theories of climatic changes, microclimate.
510. **CLOUD PHYSICS (2)** Current theories on phase changes in clouds and mechanisms responsible for precipitation; techniques of cloud modification and control.
520. **INDIRECT ATMOSPHERIC PROBING (3)** Analysis and description of measurements made with radar and bistatic radio, optical and acoustic systems used for indirect atmospheric sounding. Prerequisite: Meteo. 443.
550. **ATMOSPHERIC MOTIONS (3)** Fundamental properties and conservation requirements of the hydrodynamic equations; elements of advanced dynamic meteorology and applications to atmospheric dynamics. Prerequisite or concurrent: A.M. 451.
551. **ATMOSPHERIC WAVE MOTION (2-3)** From classical and physical hydrodynamics to the numerical prediction of wave motion in a baroclinic atmosphere. Prerequisite: Meteo. 550.
552. **NUMERICAL WEATHER PREDICTION (2-3)** Finite difference and spectral methods, barotropic and baroclinic models, filtered and primitive equation models, synoptic-scale and mesoscale models. Prerequisite: Meteo. 550.
553. **ENERGETICS OF ATMOSPHERIC MOTION (2-3)** Theoretical investigation of the conversions of energy in the atmosphere; maintenance of the general circulation and global thermodynamics. Prerequisite: Meteo. 550.
555. **ATMOSPHERIC DIFFUSION (2-3)** Dispersion of atmospheric contaminants; experiments, theory, and practical implications for air pollution problems. Prerequisite: 3 credits of statistics.
561. **CHEMISTRY OF THE ATMOSPHERE (2)** Fundamental knowledge of chemical characteristics of atmospheric components and transformations, in connection with cloud microphysics, circulation, and air pollution. Prerequisite: 3 credits in chemistry.
597. **SPECIAL TOPICS (1-6)**

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in meteorological studies are listed under Materials Science.

## MICROBIOLOGY (MICRB)

EDWIN V. GAFFNEY, *In Charge of Graduate Programs in Microbiology*  
S-306 Frear Building  
814-863-2093

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Casida, Docherty, Gaffney, Lindstrom, Ludwig, McDonel, Pootjes, Stevens, Tershak, Zarkower, and Zimmerman.

*Graduate Faculty:* Associate Members Mastro, Mizel, and Porter.

Opportunities for graduate study are available in microbiology, immunology, virology, and cell biology. Among current areas of research are included such topics as bacterial ecology, genetics, and physiology; food and industrial microbiology; photosynthesis of procaryotes; chemical and pathogenic properties of both bacterial and animal viruses; viral and tumor immunology; and mammary carcinogenesis. There is opportunity for cooperative research with other departments.

Prerequisites for admission are 12 credits in inorganic and organic chemistry, 6 in physics, 12 in biology and microbiology, and mathematics through calculus. Admission may be granted with deficiencies up to 8 credits, to be made up while pursuing graduate work. Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to

the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. A satisfactory score on the Graduate Record Examination is required for admission.

# **MICROBIOLOGY (MICRB)**

400. INTRODUCTORY ENVIRONMENTAL MICROBIOLOGY (2)
401. MICROBIAL PHYSIOLOGY AND STRUCTURE (2)
408. LABORATORY INSTRUCTIONAL PRACTICE (1-2)
410. IMMUNOLOGY AND SEROLOGY (2)
411. SURVEY OF MICROBIOLOGY (1 per term)
412. MEDICAL MICROBIOLOGY (2)
413. MICROBIAL SOIL ECOLOGY (2)
414. FOOD MICROBIOLOGY (2)
415. INTRODUCTION TO ANIMAL VIRUSES (2)
416. INDUSTRIAL MICROBIOLOGY (2)
417. EPIDEMIOLOGY (2)
418. BACTERIAL VIRUSES (2)
421. LABORATORY OF GENERAL AND APPLIED MICROBIOLOGY (2)
422. PRACTICAL MEDICAL MICROBIOLOGY (2)
450. (M.C.B. 450) MICROBIAL/MOLECULAR GENETICS (2)
460. (M.C.B. 460) MOLECULAR BIOLOGY OF EUCARYOTIC CELLS (2)
474. ADVANCED CELL BIOLOGY (2)
476. THE PHOTOSYNTHETIC PROCESS (3)
478. THE BIOLOGY OF CANCER CELLS (2)
496. INDEPENDENT STUDIES (1-12)
497. SPECIAL TOPICS (1-6)
  
507. SEMINAR (1 per term) Reports on current fields of research.
508. BACTERIAL PHYSIOLOGY (2-4) Contributions of environment, finestructure, and metabolism to the functioning cell. Prerequisite: 6 credits of biochemistry.
510. ADVANCED IMMUNOLOGY (2) Discussions of the modern concepts in immunology. Emphasis on areas of current interest. Prerequisites: Micrb. 410, 6 credits in biochemistry.
512. MICROBIOLOGICAL METHODS (1-6) Practice in special laboratory techniques of modern microbiology.
516. BACTERIAL GENETICS (2-4) Mechanisms of variation in microorganisms including mutation, adaptation, sexual recombination, transduction, and transforming factors. Prerequisites: 3 credits each in microbiology and genetics.
520. BIOCHEMICAL VIROLOGY (2) Role of enzymes and nucleic acids in virus synthesis. Regulation of virus reproduction in animal and bacterial cells. Prerequisite: 6 credits of biochemistry.
529. (C.E. 579) AQUATIC MICROBIOLOGY (3) Ecology and physiology of microorganisms of inland waters, estuaries, and oceans; microbiology of wastewater treatment. Prerequisite: introductory microbiology.
590. Colloquium (1-3)
597. SPECIAL TOPICS (1-6)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)



## MICROBIOLOGY (MICRO)

FRED RAPP, *Chairman of the Department*  
The Milton S. Hershey Medical Center  
Hershey, PA 17033  
717-534-8253

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Bartlett, Hyman, Kreider, Rapp, Taylor, M. Tevethia, and S. Tevethia.

*Graduate Faculty:* Associate Members Howett, Isom, Lipton, Marquez, Sattler, and Tenser.

This program is oriented toward the study of viruses and includes programs in viral oncology, viral genetics, tumor immunology, virus gene expression, and virus latency. The molecular biology of eukaryotic systems is an additional focus.

The communication and foreign language requirement may be satisfied by demonstrating competence in a foreign language, such as French, German, or Russian. Alternatively, courses which enhance communication skills can be substituted for the foreign language requirement.

Qualified students with undergraduate preparation in either the biological, biochemical, or physical sciences may apply. An adequate background in biology, chemistry, and mathematics and an overall grade-point average of 3.00 or better are required.

The best-qualified applicants will be accepted on a space-available basis. Formal applications should contain two letters of recommendation and a brief personal essay summarizing the background and professional goals of the applicant. Graduate Record Examination scores are required.

This program is offered only at The Milton S. Hershey Medical Center.

## MICROBIOLOGY (MICRB)

550. MEDICAL MICROBIOLOGY (4) Principles of medical microbiology: host-parasite relationships; structure and function of viruses, bacteria, and fungi as agents causing human disease.

551. MEDICAL MICROBIOLOGY (2) Principles of medical microbiology: host-parasite relationships; structure and function of viruses, bacteria, and fungi as agents causing human disease. Prerequisite: Micrb. 550.

552. MEDICAL MICROBIOLOGY LABORATORY (1) Laboratory exercises to augment Micrb. 551. Laboratory tests used to characterize microorganisms and to aid in diagnosis of disease. Concurrent: Micrb. 551.

553. SCIENCE OF VIROLOGY (3) Replication of viruses and effect on host, including transfer of genetic information, immunology, and oncogenic properties of viruses.

554. PRINCIPLES OF IMMUNOLOGY (2) Study of immune response. Nature of antigens, structure, function of antibodies, hypersensitivity, transplantation and tumor immunology, autoimmunity, and immunosuppression.

555. MICROBIAL PHYSIOLOGY AND METABOLISM (3) Physiology and comparative biochemistry of microorganisms, especially human pathogens. Regulatory mechanisms, energy metabolism, and other topics essential for cell replication.

556. MOLECULAR GENETICS (3) Structure, synthesis, and function of DNA, RNA, and proteins. Emphasis on gene structure and function in the eucaryotic cell.

557. ELECTRON MICROSCOPY (3) The application of electron microscopy to microbiology, including specimen preparation, use of the electron microscope, and photography. Prerequisites: admission to the medical or graduate program and permission of instructor.

558. MEDICAL PARASITOLOGY (2) Basic information on protozoa, helminths, arthropods, and mollusks involved in the causation of human diseases.

559. EPIDEMIOLOGY (2) Provides information on epidemiology—the study of factors that affect occurrence and course of disease in a population.

- 572. LITERATURE REPORTS (1 per term) Weekly analysis of current literature in microbiology.
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)

## MINERAL ECONOMICS (MN EC)

RICHARD L. GORDON, *In Charge of Graduate Programs in Mineral Economics*  
 221 Walker Building  
 814-865-2549

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Gordon, Schenck, Tilton, and Vogely.

The program in mineral economics prepares students in mineral industries management, administration, or economic analysis and planning. Students may specialize in such areas as commodity analysis (energy, metals, or nonmetals); resource economics (mineral policy or area studies); industrial economics (administration, market research, or financial matters); geostatistical and economic analysis of exploration and exploitation problems; or operations research and statistics (resource allocation, forecasting, or decision making).

Two related, but distinctly different, general programs for obtaining the M.S. and Ph.D. degrees are available, the one chosen depending on the education and practical experience of the candidate. One program is for students whose background is in the mineral industries and who wish to combine their scientific training with an understanding in depth of the methods by which economics can aid in solving problems in mineral industries exploration, exploitation, and processing. Requirements for admission to this program are 24 credits in chemistry, physics, mathematics, or statistics; 12 in the earth sciences; 9 in economics, mineral economics, commerce, business administration, or industrial management; and 6 in engineering subjects.

The second program is for students whose background is in economics and whose training and experience have given them an interest in applying their economic skills to the solution of mineral industries problems. Requirements for admission to this program are 12 credits in economics, mineral economics, and business administration; 6 in geological sciences; and 9 in mathematics and statistics.

The differences between the programs followed by these two groups of students will affect many aspects of their graduate programs — thesis work, required mineral economics courses, and elective selection. In all cases, the choices among courses and the emphasis within courses taken would be determined by the background of the student. The mineral-industries-based program places equal emphasis on the technical and economic aspects of mineral economics, and the economics-based program places more emphasis on the economic than on the technical features of the problems considered.

In addition to the normal degree requirements of the Graduate School, candidates for the M.S. degree must write a thesis or a professional paper and defend it orally. Doctoral candidates in the mineral-industries-based program must complete at least 15 credits in economics (including courses used for admission). M.S. students in both programs are also required to take 9-12 credits in statistics and computer science either before admission or as courses taken in addition to the minimum required for the M.S. degree. Doctoral candidates in the economics-based program must complete at least 12 credits in the earth sciences or mineral engineering. The candidacy examination for the doctorate is oral, and the oral examination for the M.S. degree at The Pennsylvania State University may be used as the candidacy examination for the doctorate. If this is done, the M.S. examination will be more detailed and broader in scope than it would be for the M.S. alone. The comprehensive examination for the doctorate includes written examinations in the major program and minor fields in addition to the oral examination required by the Graduate School. The communication requirement is satisfied by departmentally approved courses in mathematical statistics and mathematics. There is no foreign language requirement.

Students with deficiencies of 9 credits or fewer in either program may be admitted as degree candi-



dates but will be required to make up such deficiencies without these credits being applicable toward the advanced degree. Students with a 2.75 junior-senior average, above-average scores on the Graduate Record Examination Aptitude Test, and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students.

Students in this program may elect the dual-title degree program option in operations research for the Ph.D and M.S. degrees (see p. 249).

## **MINERAL ECONOMICS (MN EC)**

- 453. NONMETALLIC MINERALS (3)
- 483. ECONOMICS OF THE METALS INDUSTRIES (3)
- 484. POLITICAL ECONOMY OF ENERGY AND THE ENVIRONMENT (3)
- 490. MINERAL VALUATION (3)
- 491. MINERAL INDUSTRIES DECISION MAKING (3)
  
- 500. ADVANCED READINGS IN MINERAL ECONOMICS (3) Selected readings on topics in mineral history, mineral economics research, applications of economic theory, mineral policy and law, and mineral exploration.
- 504. ADVANCED PRINCIPLES OF MINERAL ECONOMICS (3) Minerals as capital—taxation, conservation, and land tenure; operations of mineral markets; government policy; minerals in world trade and development.
- 506. ADVANCED STUDIES IN MINERAL COMMODITIES (3) Economic studies of selected mineral commodities and their products.
- 509. (Geol. 509) GEOLOGY AND ECONOMICS OF THE CONSTRUCTION MATERIALS (3) Occurrence, origin, and marketing of the mineral materials used by the construction industry. Economic and geologic evaluation of actual deposits.
- 510. (Geol. 510) GEOLOGY AND ECONOMICS OF THE INDUSTRIAL MATERIALS (3) Occurrence, origin, and marketing of the industrial minerals and evaluation of deposits. Chemical and ceramic raw materials emphasized.
- 513. APPRAISAL OF MINERAL RESOURCES AND ANALYSIS OF EXPLORATION DECISIONS (3) Mineral resource concepts; various quantitative methods for resource evaluation, including computer simulation; exploration economics and decision making within quantitative frameworks. Prerequisite: Mn.Ec. 490.
- 519. (Econ. 519) MINERAL POLICY ANALYSIS (3) Principles of policy analysis; cost-benefit and other analytical techniques; environmental analyses; case studies of legislative and administrative mineral policy issues.
- 523. ECONOMIC ANALYSIS OF METAL INDUSTRIES (3) Economic analysis of metal supply, demand, markets, industry conduct and performance, trade, domestic and foreign policies. Prerequisite: Econ. 302.
- 524. THE ECONOMIC ANALYSIS OF ENERGY MARKETS (3) Unified theory of exploration, development, and production; its application; domestic and foreign public policies; new sources; forecasting. Prerequisite: Econ. 302.
- 529. MINERAL INVESTMENT VALUATION (3) Investment analysis for mineral properties, including reserve estimation, capital budgeting techniques under risk, taxation, capital cost, and selected investment decisions.
- 530. CONTEMPORARY ISSUES IN MINERAL FINANCE (3) Critical investigation of current problems in mineral finance, including the issues of capital availability, and domestic and foreign mineral investment. Prerequisite: Mn.Ec. 490 or Fin. 405.
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-6)

## MINERAL ENGINEERING MANAGEMENT (M E M)

R. V. RAMANI, *Section Chairman of Mineral Engineering Management*  
104 Mineral Sciences Building  
814-863-1621

*Degree Conferred:* M.Eng.

*Graduate Faculty:* Senior Members Aplan, Frantz, Given, Lovell, W. Miller, Morley, Ramani, Rosenshine, Saperstein, Schenck, Stahl, and Stefanko.

*Graduate Faculty:* Associate Members Ertekin and Guild.

This program is designed to educate engineers for advancement into executive production management positions in the mineral and heavy construction industries, in development and sales in manufacturing companies, and in consulting firms. Its aim is to provide the knowledge, skills, and attitudes needed by persons to become innovators and responsible decision-making leaders. Participants are trained to create new designs, systems, and methods, and to plan, develop, and lead mineral industry organizations.

The content of appropriate courses is based upon specific problems encountered in the mineral industries. Such courses are offered by the departments which have combined their resources to offer this interdisciplinary effort: the Departments of Mineral Engineering (Mining and Petroleum and Natural Gas sections), Mineral Economics, Materials Science and Engineering, and Industrial and Management Systems Engineering. Courses in these areas and others may be selected by students and adapted to their individual interests.

The program emphasizes quantitative methods, principles of economics applied in mineral industries, and management.

Students are required to present a scholarly written report on a suitable project, the topic of which may be suggested by industry.

For admission a bachelor's degree in one of six engineering branches of mineral industry (mining, petroleum, mineral processing, metallurgy, fuel, and ceramics) or some other closely related field (industrial, civil, geological, mechanical, or chemical engineering) is required. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

## MINERAL ENGINEERING MANAGEMENT (M E M)

510. PRODUCTION AND OPERATIONS MANAGEMENT (3-9) Overall planning, design, and selection of equipment; programming and scheduling of mineral operations; statistical control of costs and production indices.

## MINERAL PROCESSING (MN PR)

PETER T. LUCKIE, *In Charge of Graduate Programs in Mineral Processing*  
108 Steidle Building  
814-863-0373

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Aplan, Austin, Hogg, and Lovell.

*Graduate Faculty:* Associate Members Luckie and Osseo-Asare.

This program is one of the options in which a graduate student in the Department of Mineral Engineering can receive an advanced degree. After ores and minerals are mined, they are usually processed to concentrate valuable components or remove undesirable components; then they are converted into use-



ful products. The process engineering involves large plants which treat millions of tons of material per year at low cost, and is essential to such important industries as coal, power generation, steel, nonferrous metals, heavy chemicals, cement, and nonmetallic minerals. The world is facing shortages of energy, water, and raw materials, and the mineral processing engineering profession will play a key role in reducing and solving these problems. Increased efficiency and new ideas are urgently needed.

The training of a mineral processing engineer involves interdisciplinary combinations of chemistry, physics, the geological sciences, and engineering. This knowledge is then integrated with specialized knowledge — the creation, characterization, separation, agglomeration, and handling of mineral particles; the flotation and surface chemistry of mineral particles; and chemical extractions and separations — to provide the basis for developing and understanding the practical means of removal of valuable material from the rock body.

Pollution control is an important aspect of mineral processing because of the problems of disposal of large quantities of waste produced by the mining, metallurgical, cement, power, and heavy chemical industries, and the volume of process water used by these industries. Many air and water pollution control methods use equipment and processes originally developed for minerals treatment. Mineral processing methods are involved in the recycling and reuse of metals and other materials. A student may emphasize pollution control through course work and thesis research. The section also cooperates in the all-University interdisciplinary program leading to the Master of Science in environmental pollution control or the Master of Environmental Pollution Control.

The program of study for each student is decided by a study panel consisting of three faculty members and the student. The communication and foreign language requirement for the Ph.D. degree may be satisfied by reading proficiency in one foreign language. Students whose first language is English must demonstrate proficiency in German, Russian, or Japanese (or other language in which a major body of relevant technical literature exists). Students whose first language is not English will be required to show fluency in reading, speaking, comprehending, and writing English and may in some cases be required to demonstrate proficiency in one other approved language.

Graduates with bachelor's degrees in engineering, chemistry, chemical engineering, materials (ceramics, metallurgy), fuels, geological sciences, mathematics, mining, or physics are eligible for admission. Students with deficiencies may be required to make them up concurrently with their graduate studies. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds (such as industrial experience), abilities, and interests.

The following courses listed elsewhere are appropriate for Mineral Processing students: Mat.Sc. 411, 420; Metal. 401, 404, 414.

## **MINERAL PROCESSING (MN PR)**

- 401. MINERAL PROCESS ENGINEERING (3)
- 413. MINERAL PROCESSING LABORATORY (1)
- 421. PARTICLE TECHNOLOGY LABORATORY (1-3)
- 424. COAL PREPARATION (3)
- 425. INTERFACIAL PHENOMENON AND FLOTATION (3)
- 426. (Metal. 426) HYDROMETALLURGY (3)
- 427. POLLUTION CONTROL IN THE MINERAL PROCESS INDUSTRIES (3)
- 501. INTERFACIAL PHENOMENA IN MINERAL SYSTEMS (3) Applications of surface phenomena to mineral engineering systems. Thermodynamics of surfaces, flotation, adsorption of detergents, electrical double layer, flocculation, dispersion. Prerequisite: Chem. 451.
- 502. FROTH FLOTATION AND AGGLOMERATION (3) Intensive study of theory and applications of froth flotation and agglomeration. Prerequisite: Mn.Pr. 501.
- 505. PHYSICAL SEPARATIONS IN MINERAL PROCESSING (3) Intensive study of theory and applications of gravity, magnetic, electrostatic, centrifugal, and other methods of mineral processing. Prerequisite: Mn.Pr. 401.
- 506. MINERAL PROCESS PLANT DESIGN (3-10) Process design and economy. Development and quantification of flow sheets. Integration of unit operations. Plant layout, equipment selection, and instrumentation. Prerequisite: Mn.Pr. 401.

507. (Metal. 507) **HYDROMETALLURGICAL PROCESSING (3)** Fundamental physico-chemical factors underlying the aqueous extraction and recovery of metals and nonmetals from ores, minerals, and scrap metal. Prerequisite: Mn.Pr. (Metal.) 426.

508. **MINERAL PARTICLE SYSTEMS (3)** Creation, characterization, separation, and agglomeration of particles. Comminution, sizing, fractionation of powders; surface area, pore size determinations. Agglomeration and balling.

509. **PARTICLE-FLUID DYNAMICS (3)** Movement of particles in fluids, rheology of non-Newtonian mineral suspensions, design of concentrating devices, fluidized beds, electrodynamic, magnetic separations.

590. **COLLOQUIUM (1-3)**

596. **INDIVIDUAL STUDIES (1-6)**

597. **SPECIAL TOPICS (1-6)**

602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)**

## MINING ENGINEERING (MNG E)

LEE SAPERSTEIN, *Section Chairman of Mining Engineering*  
104 Mineral Sciences Building  
814-863-1619

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Senior Members Bieniawski, Frantz, Hardy, Lovell, Morley, Ramani, Saperstein, Stefanko, and Voight.

Areas of specialization which may be followed in research and course work include mine property valuation and economics of mining engineering (ore estimation, cost analysis and control, budgeting); mechanization and mine plant (unit operations, materials handling, continuous mining, mine electrical systems, power supply); development and exploitation methods (mine planning and layout, design of systems); mine management, production engineering (work and methods analysis, operations analysis); operations research, environmental control and health and safety (gas and dust technology, ventilation, air conditioning, hygiene, illumination, noise, safety, mine drainage, land reclamation, waste disposal); and rock mechanics (stress analysis, roof and ground control, penetration, fragmentation, subsidence).

Students who desire to obtain the Master of Engineering degree in mining engineering must take a minimum of 30 credits (including at least 12 credits at the 500 level) of appropriate courses in the major area and elective courses. A scholarly written report is also required. Programs of study are available in general mining engineering, rock mechanics, mine operations, research systems engineering, internal or external mine environmental control, mine health and safety; and emphasis can be given to any of the areas listed above.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by completion of courses in two languages or by completion of courses in one language and 6 credits of computer science. A thesis is required for the M.S. degree.

A bachelor's degree in mining engineering or a related engineering field is required for admission. Students may be required to make up deficiencies in their area of specialization. Certain basic related courses outside the department may be approved as part of the major. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

Students in this program may elect the dual-title degree program option in operations research for the Ph.D. and M.S. degrees (see p. 249).



**MINING (MNG)**

- 400. MINING AND OUR ENVIRONMENT (3)
- 402. MINE PLANT DESIGN (3)
- 403. MINE POWER SYSTEM AND COMMUNICATION DESIGN (3)
- 410. MINING ENGINEERING ANALYSIS (3)
- 411. MINE SYSTEMS ENGINEERING (3)
- 422. MINE VENTILATION AND AIR CONDITIONING (3)
- 431. ROCK MECHANICS (3)
- 441. SURFACE MINING SYSTEMS AND DESIGN (3)
- 451. ADVANCED MINING ENGINEERING (1-3)
  
- 502. MINE POWER SYSTEM PROTECTION (3) Protective circuitry, coordination, transient protection, and hazard reduction applied to mine power systems. Prerequisite: Mng. 403 or E.E. 425.
- 513. MINE COST ANALYSIS (3) Nature of mining costs, their analysis and control: depreciation and depletion, capital and operating costs, budgets, records.
- 514. MINE OPERATIONS ANALYSIS (3) Application of operations research techniques in determining optimal design and operating policies for mine management. Prerequisite: Mng. 411.
- 515. MINE SYSTEMS SIMULATION (3) Principles and practices of probabilistic and deterministic simulation in the analysis of operating systems related to mills and mines. Prerequisites: Cmp.Sc. 401, Mng. 411.
- 531. RHEOLOGICAL AND STRENGTH CHARACTERISTICS OF ROCKS (3) Properties of rocks and their determination; failure theories; brittle to ductile transition; rheological behavior. Prerequisite: Mng. 431.
- 532. SPECIAL TOPICS IN ROCK MECHANICS (1-3) Behavior of rock under static loading; underground stress instrumentation; experimental stress analysis; design of mine openings; theories of subsidence.
- 542. THEORY OF ROCK FRAGMENTATION (3) Behavior of rock under dynamic loads intended to fragment; physical chemistry of explosives; detonation; theory of blasting; design of drill rounds. Prerequisites: E.Mch. 13, Mng. 30, Psy. 203.
- 543. STRATA CONTROL ENGINEERING (3) Theoretical considerations; convergence, abutments, subsidence; rockbursts; underground support systems; design of mine openings. Prerequisite: Mng. 431.
- 545. ROCK MECHANICS INSTRUMENTATION (3) Strain gauge circuitry, transducers, electrohydraulic servo installations, and integrated strain and force measuring systems as applied to rock mechanics. Prerequisite: Mng. 431.
- 551. THEORY OF ROCK FAILURE (3) Mechanism of rock failure, factors of influence, theories of failure, fracture toughness, fracture propagation, time dependency, implications in engineering practice. Prerequisite: Mng. 431.
- 552. GEOMECHANICS ASPECTS OF TUNNELING IN ROCK (3) Use of tunnels; site exploration; rock mass classification; tunnel design: analytical, observational, empirical; tunnel excavation and support; large, underground chambers. Prerequisite: Mng. 431 or C.E. 446.
- 553. ROCK SLOPE ENGINEERING (3) Mechanics of slope failure; geological data collection; shear strength of rock; groundwater flow; design of rock slopes, reinforcement, and monitoring. Prerequisite: Mng. 431.
- 554. ROCK MECHANICS DESIGN I (2) Engineering design process; design in rock engineering; design of coal and hard-rock mines, tunnels, slopes, and large, underground chambers. Prerequisite: Mng. 543.
- 555. ROCK MECHANICS DESIGN II (2) Guided design concept; group design project, emphasis on creativity and innovation; ethics and professionalism in design; effective communication; project presentation. Prerequisite: Mng. 554.

- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)

## **MOLECULAR AND CELL BIOLOGY (M C B)** **(Formerly BIOPHYSICS (BPHYS))**

R. A. DEERING, *In Charge of Graduate Programs in Molecular and Cell Biology*  
201 Althouse Laboratory  
814-865-0342

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Aronson, Deering, Keith, Morgan, Person, H. Schraer, Schlegel, Smyth, Snipes, Strother, Taylor, and Todd.

*Graduate Faculty:* Associate Members Hardison, Johnson, Porter, and Tu.

The major goal of this program is to train students for independent research and teaching in molecular and cell biology, and related fields. Students may enter the program from a variety of backgrounds such as biochemistry, biology, biophysics, cell biology, chemistry, genetics, microbiology, molecular biology, physics, premedicine, or others. The student's research starts during the first year. The course work and research are individually planned by the student and the adviser, in consultation with other faculty, to achieve consistency with the background, requirements, and interests of the student. Admission is based on prior course record and grades, Graduate Record Examination, letters of recommendation, and interviews. The master's program is expected to take from six to ten terms (four terms per year), and the Ph.D. usually requires an additional eight to ten terms, including thesis research. Although the master's is usually obtained on the way to the Ph.D., exceptions are possible. Advancement to Ph.D. candidacy is decided on the basis of course and research performance in addition to a written examination. A comprehensive oral examination and thesis defense are required later in the Ph.D. program.

Research interests include biological membranes, calcification, cell fusion, chemical mutagenesis and carcinogenesis, DNA repair, flow cytofluorimetry, gene regulation, glycoprotein metabolism, electrophysiology, lysosome function, macromolecular assembly, molecular genetics, radiation biology, recombinant DNA, virology, and others.

Research and instruction in aspects of molecular and cell biology are also conducted in several other graduate programs at University Park and at The Milton S. Hershey College of Medicine.

## **MOLECULAR AND CELL BIOLOGY (M C B)**

- 415. STRUCTURE OF BIOLOGICAL MACROMOLECULES (2)
- 430. MOLECULAR BIOLOGY OF THE GENE (3)
- 440. STRUCTURE AND FUNCTION OF BIOLOGICAL MEMBRANES (2)
- 450. MICROBIAL/MOLECULAR GENETICS (2)
- 460. MOLECULAR BIOLOGY OF EUCARYOTIC CELLS (2)
- 474. PHYSICAL PROPERTIES OF BIOLOGICAL MACROMOLECULES (2)
- 475. MUTAGENESIS, CARCINOGENESIS, AND DNA REPAIR (2)
- 476. NEUROPHYSIOLOGY (3)
- 485. SENSORY SYSTEMS IN ANIMALS (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

504. (Biol. 504) SEMINAR IN CELL BIOLOGY (1) Discussion of current problems and ideas in cell biology with emphasis on reference to recent literature.



514. (Bioch. 514) **MOLECULAR BIOLOGY AND CELLULAR REGULATION** (3) Structure, synthesis, and biochemical properties of nucleic acids; protein biosynthesis; control of gene expression; molecular genetics. Prerequisite: Bioch. 402.
560. **MOLECULAR BASIS OF MUTAGENESIS AND CARCINOGENESIS** (3) Action of physical and chemical environmental agents on genetic material; DNA repair; mutagenic and carcinogenic consequences. Prerequisite: M.C.B. 430.
585. (Biol. 585) **BIOLOGICAL ULTRASTRUCTURE** (4) The application of electron microscopy to the study of cell biology. Prerequisite: Biol. 437 or 465 or Micrb. 401.
587. **ULTRACENTRIFUGATION** (2) A laboratory course in ultracentrifugation techniques including applications to biophysical problems. Prerequisite: M.C.B. 474.
588. **PHYSIOLOGY OF NERVES, MUSCLES, AND SENSE ORGANS** (2-6) Current literature of the function of nerves, muscles, and receptors. These subjects are considered individually in successive years. Prerequisite: a 400-level course in physiology, molecular and cell biology, or physiological psychology.
589. **MAMMALIAN CELL CULTURE** (3) Recent research in quantitative cell biology as studied with tissues and cells of higher organisms cultured *in vitro*. Prerequisite: Bioch. 401.
590. **COLLOQUIUM** (1-3)
595. **ELECTRON SPIN RESONANCE SPECTROSCOPY** (3) Experimental and theoretical aspects of electron spin resonance spectroscopy to provide ability for its application to biophysical problems. Prerequisite: basic knowledge of quantum mechanics and electromagnetic waves.
597. **SPECIAL TOPICS** (1-6)

## MUSIC (MUSIC)

MAUREEN A. CARR, *Director, School of Music*  
232 Music Building  
814-865-0431

*Degrees Conferred:* M.A., M.Mus.

*Graduate Faculty:* Senior Members Baisley, Brown, Carr, Fenner, D. Miller, and Perison.

*Graduate Faculty:* Associate Members J. Feldman, L. Feldman, Hopkins, P. J. Miller, Perison, Roy, Smith, Toulson, Trehy, and Trinkley.

The Master of Arts degree is academic in nature, and the program is directed toward musicological research. Admission requires the completion of a recognized music major or its equivalent, and a reading knowledge of one foreign language, either French or German. A thesis is required of all M.A. candidates. While the minimum requirement is 30 credits, the amount of course work necessary may exceed the minimum, depending on the needs and background of the student involved. At least 15 credits for the degree must be on the 500 level.

The Master of Music degree program is planned to provide professional, specialized emphasis in performance, composition, or conducting. Vocal performance students must demonstrate skill in foreign language diction. In addition to credit requirements, admission to the program is contingent upon departmental certification of the candidate's competence. According to the area of specialization, an audition or the submission of manuscripts is required. Arrangements for this may be made by the student with the department. While the minimum requirement is 36 credits, the amount of course work necessary may exceed the minimum, depending on the needs and background of the student involved. Students who lack the recommended upper-class courses in music may be required to take additional course work without receiving graduate credit.

The department sponsors musical activities, and candidates for both degrees are required to participate in positions of responsibility. All candidates for degrees are expected to be in residence for a minimum of three consecutive terms.

Students with a 2.80 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.80 grade-point average may be made for students with special backgrounds, abilities, and interests. All applicants for graduate degrees must take the Graduate Record Examination, including the Advanced Music Examination.

The School of Music is an associate member of the National Association of Schools of Music.

## MUSIC (MUSIC)

- 410. MUSIC OF THE TWENTIETH CENTURY (3)
- 412. MUSIC OF THE BAROQUE PERIOD (3)
- 413. MUSIC OF THE MIDDLE AGES (3)
- 414. MUSIC OF THE RENAISSANCE (3)
- 417. MUSIC OF THE CLASSICAL PERIOD (3)
- 418. MUSIC OF THE ROMANTIC PERIOD (3)
- \*429. VOCAL STYLE (3 per term, maximum of 18) Fee \$100.
- 455. FORM AND ANALYSIS (2)
- 457. COMPOSITION (2 per term, maximum of 16)
- 459. ORCHESTRATION AND ARRANGING (3)
- 465. FORM AND ANALYSIS (2)
- 466. ADVANCED CONDUCTING (2 per term, maximum of 12)
- 467. OPERA WORKSHOP (1-6)
- 468. ADVANCED CHAMBER MUSIC (1-6)
- 470. CONTEMPORARY TECHNIQUES (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 500. INTRODUCTION TO MUSIC REFERENCE AND RESEARCH MATERIALS (3) A study of musicological reference and research materials in English and Western European languages, with exercises in their use.
- \*501. ADVANCED HARPSICHORD (3 per term, maximum of 18) Instruction in harpsichord playing; preparation for recital performance. Fee \$100.
- \*503. ADVANCED ORCHESTRAL INSTRUMENTS (3 per term, maximum of 18) Study, repertoire building, and recital performance. Fee \$80.
- \*504. INSTRUMENTAL AND VOCAL TECHNIQUES (1-2 per term, maximum of 12) Weekly instruction in a performance area other than the student's major, emphasizing performance techniques and repertoire.
- \*511. ADVANCED PIANO (3 per term, maximum of 18) Piano literature of all periods for public performance. Fee \$80.
- \*520. VOICE (3 per term, maximum of 18) Study, repertoire building, and recital performance. Fee \$80.
- \*531. ADVANCED ORGAN (3 per term, maximum of 18) Study, repertoire building, and recital performance. Prerequisite: 4 credits of Music 31 and/or 38. Fee \$100.
- 555. ANALYTICAL TECHNIQUES (3) Advanced analysis of music of all periods.
- \*558. FREE COMPOSITION (3 per term, maximum of 18) Composition: vocal and instrumental, standard or modern idioms.
- \*560. ORCHESTRAL AND CHORAL CONDUCTING (3 per term, maximum of 18) Supervised conducting in selected performance situations, rehearsal techniques, and comprehensive score analysis.

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\*Course may be scheduled only after consultation with the director of the School of Music.



- 570. MUSIC TO 1750 (3) Studies of the development of musical styles from Gregorian chant through 1750, using reading, listening, and discussion.
- 572. SEMINAR IN MUSICOLOGY (3 per term, maximum of 9) Research in selected areas of music history.
- 580. STUDIES IN ORCHESTRAL LITERATURE (3) Selected studies in orchestral literature from the seventeenth century to the present.
- 581. STUDIES IN CHAMBER MUSIC LITERATURE (3) Selected studies in chamber music of all types from the seventeenth century to the present.
- 582. STUDIES IN KEYBOARD LITERATURE (3) The literature of major keyboard instruments from the sixteenth century to the present.
- 583. STUDIES IN CHORAL LITERATURE (3) Selected studies in choral literature of all types from the Renaissance to the present.
- 584. STUDIES IN OPERATIC LITERATURE (3) Studies in the development of the opera from 1600 to the present, treating both libretto and music.
- 585. STUDIES IN VOCAL LITERATURE (3) Selected studies in solo vocal literature of all periods.
- 589. MUSIC SEMINAR (1-6) Seminar in the history, art, and science of music, with readings, discussion, and performance.
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)
- 602. SUPERVISED EXPERIENCES IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## MUSIC EDUCATION (MU ED)

J. DAVID BOYLE, *Coordinator*  
 263 Chambers Building  
 814-865-0418

*Degrees Conferred:* D.Ed., M.Ed.

*Graduate Faculty:* Senior Members Boyle, Deihl, and Thompson.

*Graduate Faculty:* Associate Members Ramsey and Wooderson.

The School of Music offers graduate programs which help prepare students for careers in public-school music teaching, music supervision, college teaching, administration, or research. It is possible to include study in a number of these areas in the M.Ed. or D.Ed. program.

Completion of a recognized music education major, or program leading to teaching certification in music, is a prerequisite for admission to the M.Ed. or D.Ed. program. D.Ed. candidates will spend at least three consecutive terms in residence some time between admission to candidacy and completion of the degree program.

Applicants for the master's program who present a 2.75 junior-senior average and two satisfactory professional references will be considered for admission to the program in music education, provided they have appropriate course backgrounds and musical proficiency. Before each candidate's first enrollment, he or she will take a diagnostic examination in music education, music theory, and music history. The examination will provide one basis for planning the candidate's program. A comprehensive oral examination is to be passed upon completion of the course work and the master's paper.

Admission to the doctoral program requires a junior-senior minimum average of B; approximately half of any graduate credits of A quality; an interview prior to admission; five recommendations attesting to scholarship, musicianship, and ability to do independent study; and a minimum of two years of successful teaching experience in public or private schools. All applicants for graduate degrees must take the Graduate Record Examination, including the Advanced Music Examination.

The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum grade-point average may be made for students with special backgrounds, abilities, and interests.

The School of Music is an associate member of the National Association of Schools of Music.

### MUSIC EDUCATION (MU ED)

- 415. WORKSHOP IN SELECTED MUSIC EDUCATION STUDIES (1-6)
- 445. METHODS, ELEMENTARY GRADES (3)
- 446. THE ELEMENTARY MUSIC SPECIALIST (3)
- 448. METHODS, JUNIOR AND SENIOR HIGH SCHOOLS (3)
- 454. ORCHESTRA AND BAND METHODS AND MATERIALS (3)
- 468. THE TEACHING OF PIANO (3)
- 469. BAND AND ORCHESTRA TECHNIQUES (3)
- 471. TEACHING MARCHING BAND (3)
- 472. WIND INSTRUMENT MATERIALS (3)
- 473. PSYCHOLOGICAL FOUNDATIONS OF MUSICAL BEHAVIOR (3)
- 474. SELECTING AND DEVELOPING MEASURES OF MUSICAL BEHAVIOR (3)
- 480. CHORAL PROGRAM IN THE SECONDARY SCHOOL (3)
- 487. CHILDREN'S SONGS AND RECORDS (3)
- 495a. STUDENT TEACHING — ELEMENTARY GENERAL MUSIC (2-6)
- 495b. STUDENT TEACHING — SECONDARY GENERAL MUSIC (2-6)
- 495c. STUDENT TEACHING — SECONDARY CHORAL MUSIC (2-6)
- 495d. STUDENT TEACHING — INSTRUMENTAL MUSIC (2-6)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 501. PROBLEMS AND PROJECTS IN MUSIC EDUCATION (1-6) Independent work on special topics of music education pertinent to the development of curricula, methods, and materials in music education. Prerequisite: 12 graduate credits in education (including music education).
- 525. PROSEMINAR: GRADUATE STUDY IN MUSIC EDUCATION (1-3) Bibliography; location and evaluation of reference materials; organization, form, style in preparing music education research reports and other papers.
- 555. RESEARCH METHODS IN MUSIC EDUCATION (3-6) Research methods and designs for problems in music education; techniques for studying cognitive, affective, and psychomotor responses to musical stimuli. Prerequisites: Mu.Ed. 525; Ed.Psy. 475; Ed.Psy. 406 or 407.
- 569. TRENDS IN INSTRUMENTAL MUSIC (3-6) Methods and materials for school instrumental ensembles.
- 572. INSTRUMENTAL PEDAGOGY (1-6) Independent work on special problems in instrumental music pedagogy. Prerequisite: practical experience and 10 graduate credits in music and/or music education.
- 573. THE MATERIALS OF APPRECIATION (3) Examination of written and recorded materials and appropriate techniques for developing appreciation of music at elementary, secondary, and college levels.
- 574. CONTEMPORARY MUSIC CURRICULA IN THE ELEMENTARY SCHOOL (3) Developing music curricula for the elementary school incorporating current theories, practices, materials, and research data.
- 575. CONTEMPORARY MUSIC CURRICULA IN MIDDLE AND JUNIOR HIGH SCHOOLS (3) Instructional materials, procedures, and curricular activities, integration with other subjects.
- 576. MUSIC SUPERVISION (3) Current educational procedures in training music supervisors.
- 577. INTERNSHIP IN MUSIC SUPERVISION (3-6) Internship in schools under supervision of graduate faculty in music education. Prerequisites: C.&S. 581, Mu.Ed. 576.
- 581. CONTEMPORARY MUSIC EDUCATION (3) Prerequisite: 20 credits at the graduate level including Mu.Ed. 500.



## 590. COLLOQUIUM (1-3)

591. INTERNSHIP IN MUSIC PERFORMANCE TECHNIQUES (1-6) Internship in selected school or music performance situations other than those in the district where the graduate student is employed.

594. PEDAGOGY OF MUSIC THEORY, READING, AND EAR TRAINING (3) Instructional theory and materials basic to teaching music theory, reading, and ear training. Musical instruments, audio-visual devices as aids. Prerequisite: 12 credits in music theory and/or harmony.

## 596. INDIVIDUAL STUDIES (1-6)

## 597. SPECIAL TOPICS (1-6)

## 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## NUCLEAR ENGINEERING (NUC E)

WARREN F. WITZIG, *Head of the Department*  
231 Sackett Building  
814-865-4911

*Degrees Conferred:* Ph.D., M.S., M.Eng.

*Graduate Faculty:* Senior Members Diethorn, Foderaro, Jester, Kenney, Klevans, Levine, Palladino, Pillay, Remick, and Witzig.

*Graduate Faculty:* Associate Members Baratta, McGrath, and Robinson.

Programs of study are individually tailored, and engineering is emphasized through the study of reactor principles — computational methods, transport theory, and nuclear design; plasma principles — waves, analysis, and fusion laboratory; shielding — Monte Carlo and transport methods; reactor systems design — thermal, mechanical, and control; reactor fuels — configuration, radiation effects, and fuel cycle management; isotope utilization — activation analysis, chemical processes including nuclear medicine; safety analysis — reactor siting, engineered safeguards, and environmental effects. The department offers three degrees at the master's level: M.Eng., M.S. with paper, and M.S. with thesis. The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of one foreign language and proficiency in English.

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. General aptitude GRE test results are required. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

## NUCLEAR ENGINEERING (NUC E)

## 401. INTRODUCTION TO NUCLEAR ENGINEERING (3)

## 402. NUCLEAR REACTOR DYNAMICS DESIGN (3)

## 405. (Chem. 405) APPLIED NUCLEAR AND RADIOCHEMISTRY (3)

## 408. RADIATION SHIELDING (3)

## 410-411. NUCLEAR REACTOR THEORY (3 each)

## 415. RADIONUCLEAR APPLICATIONS (3)

## 420. RADIOLOGICAL SAFETY (3)

## 425. (Bioe. 425) RADIOGRAPHIC IMAGING (3)

## 428. RADIOACTIVE WASTE CONTROL (3)

## 430. DESIGN PRINCIPLES OF REACTOR SYSTEMS (3)

## 431. SYNTHESIS OF NUCLEAR SYSTEMS (3)

## 440. NUCLEAR ENGINEERING LABORATORY I (3)

## 441. NUCLEAR ENGINEERING LABORATORY II (3)

## 444. NUCLEAR REACTOR OPERATIONS LABORATORY (1)

## 490. (E.E. 490) INTRODUCTION TO PLASMAS (3)

## 496. INDEPENDENT STUDIES (1-12)

## 497. SPECIAL TOPICS (1-6)

501. REACTOR ENGINEERING (3) Reactor controls, shielding of nuclear reactors, stress analysis of reactor materials, power cycle analysis, breeding, and advanced design considerations. Prerequisite or concurrent: M.E. 412 or Nuc.E. 430; Nuc.E. 411.
502. REACTOR ENGINEERING LABORATORY (1-5) Reactor experiments devised to acquaint the student with reactor technology. Prerequisite or concurrent: Nuc.E. 411 (only if more than 1 credit of Nuc.E. 502 is taken).
503. THERMONUCLEAR ENGINEERING (3) Binary fusion reactions; microscopic and macroscopic phenomena in a completely ionized gas; electromagnetic confinement; design, operation, and diagnostics of experiments. Prerequisite: Math. 452.
505. REACTOR INSTRUMENTATION AND CONTROL (3) Neutron-detecting instruments and circuits; in-core power instrumentation; reactor control principles; control mechanisms; operational control problems. Prerequisite: Nuc.E. 411.
512. NUCLEAR FUEL MANAGEMENT (3) Nuclear fuel inventory determination and economic value through the fuel cycle. Emphasis on calculational techniques in reactor, optimization, and design. Prerequisite: Nuc.E. 411.
520. REACTOR ANALYSIS (3) Physical principles and mathematical methods of reactor analysis. Prerequisite: Nuc.E. 410.
521. NEUTRON TRANSPORT THEORY (3) Derivation of Boltzmann equation for neutron transport; techniques of approximate and exact solution for the monoenergetic and spectrum regenerating cases. Prerequisite: Nuc.E. 410 or Phys. 406.
540. (E.E. 540) THEORY OF PLASMA WAVES (3) Solutions of the Boltzmann equation; waves in bounded and unbounded plasmas; radiation and scattering from plasmas. Prerequisite: Nuc.E. 490.
541. (E.E. 541) PLASMA THEORY (3) Advanced topics in kinetic theory, fluctuation theory, micro-instability, and turbulence. Prerequisite: Nuc.E. (E.E.) 540.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-6)
597. SPECIAL TOPICS (1-6)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## NURSING (NURS)

JOAN M. RINEHART, *In Charge of Graduate Program in Nursing*  
201 East Human Development Building  
814-863-0245

*Degree Conferred:* M.S.

*Graduate Faculty:* Senior Members Gunter, Newman, and Susman.

*Graduate Faculty:* Associate Members Igou, Laubach, Mandrillo, Metzger, O'Brien, Rinehart, Sanderson, Therrien, and Williamson.

The Master of Science degree in nursing is offered in recognition of the completion of a program which emphasizes productive scholarship and research in the preparation of the advanced nursing practitioner. The program is accredited by the National League for Nursing (NLN).

Each student must earn a minimum of 40 graduate credits with at least 30 earned as approved resident credits. A core of 9 credits in nursing theory, research, and models of practice is required of all students. Students may select an area of specialization in nursing practice for 21-25 credits (including electives), from among family health, community health, and adult health and aging. In addition, 6-10 credits are required for statistics and thesis work; each student must complete a thesis.

Applicants should hold a baccalaureate degree in nursing from an NLN-accredited program and must submit the official results of the verbal and quantitative tests of the Graduate Record Examination.



tion. An overall grade-point average of 3.00 on a 4.00 scale is expected for undergraduate work. Courses in basic statistics and introduction to nursing research are required. Applicants who do not meet the established criteria may be considered on an individual basis.

## **NURSING (NURS)**

- 401. CONCEPTS OF HEALTH (3)
  - 402. HOLISTIC HEALTH (3)
  - 405. OCCUPATIONAL HEALTH NURSING (3)
  - 410. NURSING CARE OF THE FAMILY IN THE COMMUNITY (3)
  - 425. SCHOOL HEALTH NURSING (3)
  - 445. TRAUMA NURSING (3)
  - 450. REHABILITATION NURSING (3)
  - 455. ADVANCED MEDICAL NURSING (3)
  - 460. ADVANCED SURGICAL NURSING (3)
  - 464. DYING AND DEATH (3)
  - 486. INTRODUCTION TO NURSING SERVICE ADMINISTRATION (2)
  - 495. NURSING STUDY IN SPECIALIZED SETTING (1-12)
  - 496. INDEPENDENT STUDIES (1-12)
  - 497. SPECIAL TOPICS (1-6)
- 
- 501. ISSUES IN NURSING AND HEALTH CARE (2) Consideration of personal, social, political, economic, philosophical, ethical problems/questions and ways of confronting and resolving conflicts in professional practice.
  - 510. THEORETICAL FOUNDATIONS OF NURSING (3) Examines current conceptual models in nursing and relationship of empirical data and existing theories to the development of nursing science.
  - 511. DESIGN AND ANALYSIS OF CLINICAL STUDIES IN NURSING (3) Research design for problems of developing and evaluating nursing care programs, products, methods, and procedures. Prerequisite: completion of (or concurrent with) a course in advanced statistics.
  - 512. MODELS OF NURSING PRACTICE (3) Integration and application of current nursing theory and research to the development of a model of nursing practice. Prerequisites: Nurs. 510, 511.
  - 530. CLINICAL PROCESS IN NURSING PRACTICE (1-10) Application of a model of nursing practice to a selected client population. Prerequisite: completion of advanced nursing theory courses in selected clinical areas.
  - 550. TRANSCULTURAL HEALTH NURSING (3) Theoretical background for design, implementation, evaluation of nursing care to promote, maintain, and restore health, congruent with cultural patterns.
  - 590. COLLOQUIUM (1-3)
  - 596. INDIVIDUAL STUDIES (1-6)
  - 597. SPECIAL TOPICS (1-6)
  - 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## NUTRITION (NUTR)

HELEN A. GUTHRIE, *In Charge of Graduate Programs in Nutrition*  
106 Henderson Human Development Building  
814-863-0772

*Degrees Conferred:* Ph.D., M.S., M.Ed.; M.S. in Nutrition in Public Health

*Graduate Faculty:* Senior Members Fosmire, Green, Guthrie, McClearn, Shannon, Sims, and Wright.

*Graduate Faculty:* Associate Members Blair, Byrd-Bredbenner, Kris-Etherton, and Massaro.

Graduate programs in nutrition prepare students for careers in college teaching, research, industry, and government. The 45-credit program in nutrition in public health prepares the student for work in public health and community agencies and requires an eight-week field experience.

To satisfy the communication and foreign language requirement for the Ph.D. degree, students are expected to demonstrate competence in technical writing (e.g., Engl. 418) and spoken English.

For admission to a graduate program in nutrition, a student must have completed at least 6 credits in inorganic and organic chemistry, 3 each in biochemistry, microbiology, and human physiology, 4 in other physical and biological sciences, and 8 in foods and/or nutrition. For admission to the program in nutrition in public health, an additional 12 credits in social sciences are required.

Students with a 2.80 junior-senior average, appropriate course backgrounds, and an acceptable score on the Graduate Record Examination will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Students with up to 8 credits of deficiency may also be admitted. Any deficiencies must be completed with a grade of B within two terms.

For other graduate courses in nutrition see A.Ntr. 501, Energy Metabolism, and A.Ntr. 503, Micronutrients: Nutrition, Metabolism, and Function, and A.I. 514, Animal Growth and Development. Current topics are presented as announced in Nutr. 597. Students are expected to participate in Nutr. 590, Colloquium, each term and enroll in Nutr. 551, Seminar in Nutrition, two terms per year.

## NUTRITION (NUTR)

- 400. INTRODUCTION TO NUTRITION COUNSELING (1-3)
- 420. EXPERIMENTAL FOODS (4)
- 421. CULTURAL ASPECTS OF FOODS (3)
- 422. ADVANCED FOODS (3)
- 452. NUTRITIONAL ASPECTS OF DISEASE (3)
- 453. DIET THERAPY (2)
- 454. LABORATORY METHODS IN NUTRITION (2)
- 456. COMMUNITY NUTRITION (3)
- 457. PRINCIPLES OF HUMAN NUTRITION (3)
- 458. DEVELOPMENTAL NUTRITION (2)
- 459. ADVANCED NUTRITION (3)
- 490. FOODS AND NUTRITION SEMINAR (1)
- 495. ADVANCED FIELD EXPERIENCE IN NUTRITION (1-6)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

522. ADVANCED EXPERIMENTAL FOODS (3) Experimental methods used in measuring the quality of foods; specific problems in food preparation.

530. PROBLEMS IN FOODS AND NUTRITION (1-6)

550. READINGS IN NUTRITION (3) Readings and reports of selected topics in nutrition.

551. SEMINAR IN NUTRITION (1-6) Selected topics and recent advances in nutrition.

552. NUTRITION IN DISEASE (2) Physiological and biochemical problems in metabolic diseases and the nutritional aspects of therapy.



555. **FIELD WORK IN NUTRITION (2-4)** Field problems planned to meet the needs of individual students. Hours and problems to be arranged.
556. **THE SURVEY METHOD IN FOODS AND NUTRITION (2)** Study of survey techniques as a tool in the assay of food adequacy and nutritional status.
557. **INTERRELATIONSHIPS OF NUTRIENTS (2)** Interrelationships of nutrients in the metabolic processes; their significance as applied to nutrition.
558. **PROTEIN NUTRITION (2)** Classical concepts, recent developments, and applied aspects of protein and amino acid nutrition and metabolism. Prerequisite: graduate standing in nutrition or related field.
560. **PUBLIC HEALTH NUTRITION (3)** Overview of public health nutrition field and profession: administration of public health nutrition programs, including program planning, implementation, and evaluation. Prerequisites: Nutr. 453, 456.
561. **PUBLIC HEALTH NUTRITION: PROGRAMS/SERVICES (2)** Organization of the nutrition component of programs administered by health agencies; application of knowledge and skills to effect planned change. Prerequisite: Nutr. 560.
590. **COLLOQUIUM (1-3)**
596. **INDIVIDUAL STUDIES (1-6)**
597. **SPECIAL TOPICS (1-6)**
602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)**

## OPERATIONS RESEARCH (OR)

A. V. WILLIAMS, *Chairman of the Committee on Operations Research*  
 324 Walker Building  
 814-865-2493

*Degrees Conferred:* Students electing this option through participating graduate programs will earn a degree with a dual title at both the Ph.D. and the M.S. or M.A. levels, i.e., Ph.D. in (graduate program name) and Operations Research, or M.S. or M.A. in (graduate program name) and Operations Research.

*Graduate Faculty:* Senior Members Aggarwal, Antle, L. Austin, Biles, K. W. Crowley, Enscoe, Gordon, Gould, Guild, Haight, Hallberg, Harkness, Hayya, Heitmann, Hottenstein, Hu, Ignizio, D. B. Johnson, Kleindorfer, C. G. Knight, Kochenberger, J. Lewis, Mann, McMurtry, Y. Mehra, W. Myers, J. Nelson, Parsons, Partenheimer, Ramani, Raphael, Rigby, Rosenshine, T. A. Ryan, Shilling, Tilton, Turner, Willenbrock, and A. V. Williams.

*Graduate Faculty:* Associate Members Beierlein, Chandra, Chen, Dunn, Kibler, W. Mills, Pegden, E. Reutzel, R. A. J. Taylor, H. R. Thomas, and Zindler.

The operations research dual-title degree program option is administered by an Operations Research Committee, which is responsible for management of the program. The committee maintains program definition, identifies faculty and courses appropriate to the option, and recommends policy and procedures for its operation to the dean of the Graduate School. This dual-title degree program is offered as an option through graduate major programs in eight colleges. The option enables students from diverse graduate programs to attain and be identified with the tools, techniques, and methodology of operations research, while maintaining a close association with areas of application. Operations research is the analysis — usually involving mathematical treatment — of a process, problem, or operation to determine its purpose and effectiveness and to gain maximum efficiency. To pursue a dual-title degree under this program option the student must apply to the Graduate School and register through one of the following graduate major programs: agricultural economics, business administration, civil engineering, computer science, economics, educational administration, electrical engineering, entomology, forest resources, geochemistry and mineralogy, geography, industrial engineering, man-environment relations, mathematics, mineral economics, mining engineering, petroleum and natural gas engineering, and statistics.

For the Ph.D. degree with operations research option, in addition to those prescribed by the graduate major program, prerequisites for acceptance to the program without deficiency include the following or their equivalent: Math. 161, 162, 240, 250, and 263; Cmp.Sc. 101; and 6 credits in elementary or introductory micro- or macroeconomics. There are no prerequisites for admission to the M.S. or M.A. program option other than those that may be imposed by the participating graduate major programs.

To qualify for a dual-title degree, students must satisfy the requirements of the graduate major programs in which they are enrolled, in addition to the minimum requirements, or their equivalent, in the operations research option. Students must enroll in O.R. 590, Colloquium, for at least 1 credit in each year enrolled in the program and in residence.

The minimum requirements for the Ph.D. degree with operations research option are (1) Mathematics — 9 credits minimum including real analysis (Math. 420) and linear algebra (Math. 441); (2) Statistics — 9 credits minimum with a 6-credit sequence in mathematical statistics (Stat. 409, 410) or in experimental statistics (Stat. 401, 402) and 3 credits in stochastic processes (Stat. 427); (3) Optimization — 12 credits minimum including linear programming I and II, mathematical programming I, and dynamic programming; (4) Processes — 9 credits minimum including inventory models, scheduling models, and waiting line models; (5) Computer Science — 6 credits minimum including numerical methods and digital simulation techniques; and (6) Open Areas (application and/or specialization) — 15 credits minimum.

For the M.S. or M.A. degree with operations research option, 18 credits are required from the areas of statistical methods, computer science, optimization (survey-level courses acceptable), processes (survey-level courses acceptable), and applications. (Application courses are those that involve problem solving through the use of decision methods.) At least 3 credits must be selected from each area. Particular courses may satisfy both the graduate major program requirements and those in the operations research option. A thesis may be required, the supervisor of which must be a member of the Graduate Faculty recommended by the chairman of the program granting the degree and approved by the Operations Research Committee as qualified to supervise thesis work in operations research. A paper or report may be written in lieu of the M.S. or M.A. thesis upon approval of the student's graduate major program. A student selecting the paper or report must take an additional 6 credits in the operations research program. It is the prerogative of the graduate major program to assign these credits to one or more of the following categories: statistical methods, computer science, optimization, processes, and applications.

A Ph.D. minor program in operations research is available for doctoral students in graduate programs who find it advantageous to include advanced quantitative methods of systems analysis in their program of study and have been approved to do so by their doctoral committee. To qualify for a minor in operations research, students must satisfy the requirements of their graduate major program and take at least 15 credits from the following areas: statistical methods or mathematical statistics, computer science, optimization, and processes. At least 3 credits must be taken from each of optimization and processes areas as listed below.

The doctoral committee is recommended by the graduate major program granting the degree. The chairman and at least two members of a doctoral committee must be members of the Graduate Faculty and approved by the Operations Research Committee as qualified to supervise doctoral theses in operations research. The Operations Research Committee is responsible for administering an examination in operations research which constitutes a portion of the comprehensive examination administered to the doctoral student in the program option, as well as to the candidate who chooses operations research as a minor field.

Courses of a like nature identified as the core of the program option have been given generic names and descriptions. Each such listing may be satisfied by one of the courses given under it.

#### OPTIMIZATION AREA

**Linear Programming I** An introduction to the theory and methodology of linear programming.

I.E. 405

Q.B.A. 451

**Linear Programming II** A further treatment of the theory and methodology of linear programming with emphasis on special formulations.

I.E. 510



**Mathematical Programming I** Introduction to optimization theory designed to provide the necessary fundamentals for nonlinear programming and more advanced studies in mathematical programming.  
Q.B.A. 452

**Mathematical Programming II** An in-depth treatment of nonlinear programming and geometric programming with emphasis on both theory and applications.  
Q.B.A. 540

**Mathematical Programming III** A seminar dealing with recent advances in mathematical programming.  
Q.B.A. 550

**Dynamic Programming** Study of the concepts underlying model building and optimization of dynamic systems, with applications to engineering, economic, and environmental systems.  
I.E. 519  
Stat. 534 (M.E.R. 534)

**Goal Programming** Study of concepts and methods in analysis of systems involving multiple objectives, with applications to engineering, economic, and environmental systems.  
I.E. 520

## PROCESSES AREA

**Inventory Models** A study of inventory theory, deterministic and probabilistic models, single and multiproduct models in single- and multistage processes.  
I.E. 508  
Mgmt. 518

**Scheduling Models** Scheduling models with simultaneous job arrival and probabilistic job arrival, network scheduling, and scheduling simulation techniques.  
I.E. 507  
Mgmt. 516

**Waiting Line Models** Theory of systems involving stochastic delay and stochastic service.  
I.E. 509

## OPERATIONS RESEARCH (O R)

590. COLLOQUIUM (1-3)

## PETROLEUM AND NATURAL GAS ENGINEERING (PNG E)

C. DREW STAHL, *Section Chairman of Petroleum and Natural Gas Engineering*  
207 Mineral Sciences Building  
814-865-6082

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Member Stahl.

*Graduate Faculty:* Associate Members Ertekin and Jacoby.

Areas of specialization include experimental and theoretical studies of water flooding and the newer methods for displacing oil from porous media, methods for calculating reservoir performance, scaled laboratory studies of reservoir phenomena, and drilling and well completion problems.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of one foreign language.

Students who expect to enter graduate study in this program with a degree in another major should present 6 credits in geology, 15 in engineering science, and credit for mathematics through integral calculus. A limited number of deficiencies may be made up after admission. Certain closely related courses outside the department may be counted as petroleum and natural gas credits toward the degree.

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

Students in this program may elect the dual-title degree program option in operations research for the Ph.D. and M.S. degrees (see p. 249).

## **PETROLEUM AND NATURAL GAS (P N G)**

- 400. THESIS (1-6)
- 410. APPLIED RESERVOIR ENGINEERING (3)
- 420. APPLIED RESERVOIR ANALYSIS (3)
- 421. RESERVOIR ENGINEERING (3)
- 425. PRINCIPLES OF WELL TESTING AND EVALUATION (3)
- 430. RESERVOIR MODELING (3)
- 440. FORMATION EVALUATION (3)
- 450. DRILLING DESIGN AND PRODUCTION ENGINEERING (3)
- 475. PETROLEUM ENGINEERING DESIGN (3)
- 480. PRODUCTION PROCESS ENGINEERING (3)
- 481. NATURAL GAS AND GASOLINE PLANTS (2)
- 485. ENGINEERING IN SECONDARY RECOVERY (3)
- 486. TERTIARY OIL RECOVERY METHODS (3)
- 493. ENGINEERING EVALUATION OF OIL AND GAS PROPERTIES (3)
  
- 510. SOLUTION OF THE PARTIAL DIFFERENTIAL EQUATIONS OF FLOW IN POROUS MEDIA (3) The application of mathematical techniques to solve the partial differential equations of steady and unsteady state flow in porous media. Prerequisite: Math. 405.
- 511. NUMERICAL SOLUTION OF THE PARTIAL DIFFERENTIAL EQUATIONS OF FLOW IN POROUS MEDIA (3) Differencing schemes for the partial differential equations of single-phase flow; application to flow of gas and mixing in porous media.
- 512. NUMERICAL RESERVOIR SIMULATION (3) Mathematical analysis of complex reservoir behavior and combination drives; numerical methods for the solution of behavior equations; recent developments. Prerequisite: P.N.G. 510.
- 513. ADVANCED NUMERICAL RESERVOIR SIMULATION (3) Compositional simulation; history-matching theory; simulation of basic processes involving heat and mass transfer in porous media. Prerequisite: P.N.G. 512.
- 514. OPTIMIZATION OF PETROLEUM RECOVERY PROCESSES (3) Optimum search methods, linear programming, nonlinear programming, dynamic programming, application to water flooding, depletion drive, steam injection, gas cycling, miscible displacement. Prerequisite: P.N.G. 410.
- 515. ADVANCED OIL RECOVERY TECHNIQUES (3) Advanced oil recovery techniques including water flooding, in situ combustion, steam injection, hot-water injection, and miscible-phase displacement.
- 519. DESIGN OF THERMAL RECOVERY PROJECTS (3) Suitability of reservoirs for thermal oil recovery; case histories; design of in situ combustion and steamfloods; thermal stimulation; shale oil recovery. Prerequisite: P.N.G. 515.
- 520. PHASE RELATIONS IN RESERVOIR ENGINEERING (3) Phase relations as applied to condensate and retrograde condensate reservoirs and to other problems in petroleum production.
- 530. NATURAL GAS ENGINEERING (1-3) Flow in producing or storage reservoirs; gas well testing; transmission systems; storage cycle; current developments. Prerequisite: P.N.G. 481.
- 550. ADVANCED ENGINEERING EVALUATION OF OIL- AND GAS-PRODUCING PROPERTIES (3) Selected topics of current research and development interest in formation evaluation, geophysical well logging, and production economics. Prerequisites: P.N.G. 440, 493.



590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in petroleum and natural gas studies are listed under Materials Science.*

## PHARMACOLOGY (PHARM)

ELLIOT S. VESELL, *Chairman of the Department*  
The Milton S. Hershey Medical Center  
Hershey, PA 17033  
717-534-8285

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Berlin, Beyer, Connor, Fritz, Greene, Hayes, Jacob, Severs, and Vesell.

*Graduate Faculty:* Associate Members Dvorchik, Liu, Lloyd, Luderer, Passananti, Rose, Schneck, Sloviter, Smith, Summy-Long, and Ward.

The graduate studies program in pharmacology is designed to give qualified students a combination of didactic instruction, informal direction, and laboratory experience which will enable them to obtain a firm foundation in the principles, methods, and contributions of pharmacology (defined broadly as the science of the multiple aspects of the interaction of chemical agents with biological systems). With this preparation, graduates of the program should be capable of designing and executing high-quality independent research, and of assuming positions of responsibility within the pharmacologic community.

The department offers studies in the general areas of drug metabolism, molecular pharmacology, endocrine pharmacology, neuropharmacology, cardiovascular-renal pharmacology, and clinical pharmacology. Primary emphasis is placed on the molecular mechanism by which drugs act in the body and by which the body transforms drugs.

A bachelor's degree reflecting a reasonable background in zoology or biology, mathematics, and chemistry is required; reading knowledge of one or two foreign languages is recommended. Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. Two letters of recommendation are required, along with a curriculum vitae and Graduate Record Examination scores.

This program is offered only at The Milton S. Hershey Medical Center.

## PHARMACOLOGY (PHARM)

501. PHARMACOLOGY (4) Lectures, discussions, and laboratory study of the mechanism of drug action in biological systems.

502. PHARMACOLOGY (4) Continuation of Pharm. 501.

504. DRUG METABOLISM (3) Study of chemical transformation of drugs within animal cells and drug-metabolizing enzymes present in liver microsomes performing this function. Prerequisite: Pharm. 501.

505. PHARMACOKINETICS (3) Quantitation of the time courses of absorption, distribution, metabolism, and excretion of drugs in the intact organism. Prerequisite: Pharm. 501, 502, or 520.

510. MOLECULAR TURNOVER IN ANIMALS (3) In-depth consideration of the dynamic state of body constituents as applied to carbohydrates, lipids, nucleic acids, and particularly to proteins. Prerequisite: Bchem. 502.

511. MOLECULAR MECHANISM OF ACTION OF DRUGS (2) Series of lectures and informal discussion on the molecular mechanism of action of some drugs and their clinical applications. Prerequisite: Bchem. 502.

- 512. CLINICAL PHARMACOLOGY (3) Drug therapy of cardiovascular, renal, and neural diseases.
- 515. HUMAN GENETICS (2) Seminar-type presentations by students and staff on fundamental problems and current topics in human genetics.
- 520. PRINCIPLES OF DRUG ACTION (2) Detailed analysis of basic parameters governing drug actions.
- 525. PHARMACOLOGY OF ANTITUMOR DRUGS (2) Study of the mechanisms of antitumor drug action in biological systems. Prerequisite: Pharm. 501.
- 530. PHARMACOLOGY OF PSYCHOTROPIC DRUGS (2) Systematic analysis of the effects of psychotropic drugs.
- 540. PHARMACOGENETICS (3) Study of human responses to individual drugs.
- 549. NEURAL SUBSTRATES FOR DRUG ACTION (2) Correlation of the sites of action within the central nervous system where certain common drugs exert major effects. Prerequisites: Pharm. 501, 502.
- 550. NEUROPHARMACOLOGY (2) Study of mechanisms of action of drugs which alter neuronal transmission in the peripheral and central nervous systems.
- 571. TECHNIQUES IN PHARMACOLOGICAL RESEARCH (2) Classes will be comprised of lectures by the faculty of the Department of Pharmacology, followed by working demonstrations of the techniques.
- 575. DEVELOPMENT OF RENAL DRUGS (3) The development and clinical application of new therapeutic agents, using one or more prototype drugs as examples. Prerequisites: Pharm. 501, 502.
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)

## PHILOSOPHY (PHIL)

CARL R. HAUSMAN, *Head of the Department*  
 246 Sparks Building  
 814-865-6397

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Senior Members Flay, Hausman, Johnstone, Kockelmans, Lingis, Rosen, Seebohm, Vaught, and Verene.

*Graduate Faculty:* Associate Members Ginsberg, Grosholz, Helman, McKenzie, Price, and Tsugawa.

A thorough grounding in the history of philosophy is desirable for all students. Specialization is possible in areas (such as aesthetics, metaphysics, ethics, social philosophy, logic, and history and philosophy of science); in movements of thought (such as rationalism, empiricism, idealism, phenomenology, and existentialism); or in any of the major figures in the history of Western philosophy. Specialization is also possible in a joint program with the Department of Mathematics in logic and the foundations of mathematics, and with the Department of Physics in philosophy of science. Undergraduate preparation to the extent of a strong minor is advisable. The department may waive the requirement of a thesis for an M.A. candidate.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of two foreign languages or by comprehensive knowledge of one.

Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.



**PHILOSOPHY (PHIL)**

- 400. THE HISTORY OF ETHICS (3)
  - 403. ENVIRONMENTAL ETHICS (3)
  - 406. MEDIEVAL PHILOSOPHY (3)
  - 408. STUDIES IN SOCIAL AND POLITICAL PHILOSOPHY (3)
  - 410. STUDIES IN GREEK PHILOSOPHY (3-6)
  - 411. STUDIES IN MODERN PHILOSOPHY (3-6)
  - 412. STUDIES IN CONTEMPORARY PHILOSOPHY (3-6)
  - 413. PHILOSOPHY OF LITERATURE (3)
  - 414. AESTHETIC THEORY (3)
  - 417. STUDIES IN NINETEENTH-CENTURY PHILOSOPHY (3-6)
  - 419. PHILOSOPHICAL BACKGROUNDS OF AMERICAN THOUGHT (3)
  - 420. PHILOSOPHY OF HISTORY (3)
  - 421. STUDIES IN THE PHILOSOPHY OF SCIENCE (3)
  - 424. STUDIES IN PHILOSOPHY OF RELIGION (3)
  - 426. METAPHYSICS (3-6)
  - 427. ADVANCED ETHICS (3)
  - 428. (Math. 428) LOGICAL THEORY (3)
  - 429. SEMANTICS: PHILOSOPHY OF LANGUAGE AND SYMBOLISM (3)
  - 432. (S.T.S. 432) MEDICAL ETHICS (3)
  - 435. (S.T.S. 435) THE INTERRELATION OF SCIENCE, PHILOSOPHY, AND RELIGION (3)
  - 442. MODAL LOGIC (3)
  - 449. LOGIC IN PHILOSOPHY (3)
  - 494. (Ph.Ed. 494) MAN, WORLD, AND SPORT — A PHILOSOPHICAL INQUIRY (3)
  - 496. INDEPENDENT STUDIES (1-12)
  - 497. SPECIAL TOPICS (1-6)
- 
- 500. ETHICS: HISTORICAL AND SYSTEMATIC (2-6) Critical study of some phase of ethical theory, or of some period of the history of ethics.
  - 504. SOCIAL AND POLITICAL PHILOSOPHY (3-6) Critical study of basic problems in their historical and functional setting.
  - 505. PHILOSOPHY OF WESTERN RELIGION (3-6) The consideration of contemporary Western religious concepts in terms of their Graeco-Judean traditions.
  - 506. SEMINAR IN ANCIENT PHILOSOPHY (3-6) Study of one or more important men or movements in ancient philosophy.
  - 508. SEMINAR IN MODERN PHILOSOPHY (3-6) Men and movements in philosophy from the Renaissance through the nineteenth century.
  - 509. SEMINAR IN CONTEMPORARY PHILOSOPHY (3-6) Men and movements in twentieth-century philosophy.
  - 512. ADVANCED TOPICS IN PHILOSOPHY OF SCIENCE (3-6) Crucial problems in the theory of science and scientific method.
  - 513. (Psy. 513) PRINCIPLES AND METHODS OF EMPIRICAL SCIENCE (3) Scientific methodologies and their presuppositions, with special emphasis on behavioral and social sciences.
  - 514. SEMINAR IN NINETEENTH-CENTURY PHILOSOPHY (3-6) Study of a philosopher or philosophical movement of the nineteenth century.
  - 515. PHILOSOPHICAL METHOD (3-6) Methods proposed by classical and contemporary thinkers for reaching philosophical conclusions: deductive, inductive, dialectical, pragmatic, intuitive.
  - 516. SEMINAR IN AESTHETICS (3-6) Problems and theories in the nature of art.
  - 526. SEMINAR IN METAPHYSICS (3-6) Formulation and analysis of metaphysical problems in the various fields of philosophy.

530. PHILOSOPHY RESEARCH SEMINAR (1-12) Study of selected philosophical problems with an emphasis on techniques of philosophical research.
543. PROPOSITIONAL AND PREDICATE LOGIC (3) The theory and metatheory of propositional logic, with an introduction to predicate logic.
554. (Math. 554) LOGIC AND METAMATHEMATICS (3) Completeness, Lowenheim-Skolem, and compactness theorems. First-order arithmetic, recursiveness, and the incompleteness and consistency of arithmetic. Prerequisite: Phil. 428.
590. COLLOQUIUM (1-3)
597. SPECIAL TOPICS (1-6)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## PHYSICAL EDUCATION (PH ED)

LUCILLE I. MAGNUSSON, *Head of the Department*  
271 Recreation Building  
814-863-0441

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Senior Members Buskirk, Cavanagh, Christina, Harris, Hodgson, Kamon, Lucas, Lundegren, Mendez, Morehouse, Nelson, Smith, and Stoedefalke.

*Graduate Faculty:* Associate Members Gallagher, Magnusson, Nicholas, Sabock, Scannell, and Thompson.

The master's program is research oriented and is designed to increase a student's professional competence as a teacher and future doctoral candidate, while the doctoral program is directed toward careers in research and in teaching at the advanced undergraduate and graduate levels in colleges and universities. The graduate programs are directed toward involvement of the student in gaining greater depth of understanding regarding the foundations of physical education. All degrees require experience with research to enable the student to better analyze problems, assess information, draw logical conclusions, and apply research findings.

Areas of specialization include (1) adapted physical education, (2) administration and curriculum, with a sub-area in sports administration, (3) biomechanics, (4) exercise specialist, (5) history of sport and physical education, (6) motor learning, (7) performance assessment, (8) physiology of exercise, and (9) sport psychology and motor behavior.

Admission to the graduate program requires a bachelor's or master's degree in physical education or its equivalent in comparable course work and acceptable performance on the Graduate Record Examination. Especially desirable is a concentration in the physical, biological, behavioral, or social sciences depending upon the intended area of specialization. Admission to doctoral study requires demonstrated research ability in the form of a thesis or published research. Students must demonstrate proficiency in use of the English language. The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of one foreign language — French, German, Russian, Spanish, or another language upon petition.

Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. Graduate Record Examination scores are required for all graduate program applicants.

## PHYSICAL EDUCATION (PH ED)

400. ADAPTED PHYSICAL EDUCATION (3)
402. PHYSICAL EDUCATION FOR CHILDREN WITH LEARNING PROBLEMS (2)
412. CONTEMPORARY PROBLEMS OF TEACHING PHYSICAL EDUCATION IN THE INNER CITY SCHOOLS (3)



420. PSYCHOSOCIAL DIMENSIONS OF PHYSICAL ACTIVITY (3)
424. THE FEMALE IN EXERCISE AND SPORT (3)
441. HISTORY OF SPORT IN AMERICAN SOCIETY (3)
442. SPORT IN ANTIQUITY (3)
450. CURRENT RESEARCH LITERATURE IN PHYSICAL EDUCATION (3)
452. METHODS, MATERIALS, AND PRINCIPLES OF PHYSICAL EDUCATION IN THE ELEMENTARY SCHOOL (3)
455. STATISTICAL METHODS IN HEALTH, PHYSICAL EDUCATION, AND RECREATION (3)
456. PHYSICAL FITNESS APPRAISAL (3)
457. EXERCISE PRESCRIPTION (2)
460. METHODS AND PRINCIPLES OF ATHLETIC COACHING (3)
462. ADMINISTRATION OF ATHLETIC PROGRAMS (2)
463. ACQUISITION OF MOTOR SKILLS (3)
470. HISTORY AND THEORY OF DANCE IN EDUCATION (2)
471. EUROPEAN AND AMERICAN FOLK DANCE (2)
480. EXERCISE PHYSIOLOGY (3)
483. MOTOR PATTERNS OF CHILDREN (3)
484. SPORT BIOMECHANICS (3)
489. INTRAMURAL ATHLETICS (3)
490. MEASUREMENT AND EVALUATION IN HEALTH AND PHYSICAL EDUCATION (2)
491. ORGANIZATION AND ADMINISTRATION OF HEALTH AND PHYSICAL EDUCATION IN SCHOOLS (3)
494. (Phil. 494) MAN, WORLD, AND SPORT — A PHILOSOPHICAL INQUIRY (3)
- 495a. PRACTICUM IN STUDENT TEACHING (10)
- 495b. FIELD AND/OR RESEARCH PRACTICUM IN PHYSICAL EDUCATION (3-10)
496. INDEPENDENT STUDIES (1-12)
497. SPECIAL TOPICS (1-6)
500. (Rc.Pk. 500) INDIVIDUAL STUDY AND RESEARCH PROJECTS (1-10) Prerequisite: Ph.Ed. 530.
520. PSYCHOLOGY OF SPORT (3) Study of man's psychological behavior in sport and physical activity; development of somatopsychic theory of physical activity. Prerequisite: 6 credits in psychology.
522. SPORT IN SOCIETY (3) Examination of the cultural phenomenon of sport; social behavior in sport; institution of sport and relationship with other social institutions. Prerequisite: 3 credits in sociology.
525. SOCIAL PSYCHOLOGY OF SPORT (3) Theory and research concerning the social-psychological basis for understanding social interaction and performance in team and individual sport settings. Prerequisite: 3 credits in social psychology at the 400 or 500 level.
530. (Hl.Ed. 530, Rc.Pk. 530) RESEARCH TECHNIQUES IN HEALTH AND PHYSICAL EDUCATION AND RECREATION (3) Research techniques, including methods, research design, techniques for data collection, as applied to relevant problems in the health education field.
532. TESTS AND MEASUREMENTS IN PHYSICAL EDUCATION (3) Critical study of tests and measurements available in physical education; methods of constructing and evaluating new tests and measurements. Prerequisite: Ph.Ed. 490.
534. STUDIES IN CURRICULUM CONSTRUCTION IN PHYSICAL EDUCATION (3) Principles and methods of curriculum building in physical education; different psychological and educational points of view, organizing a course of study committee, making units of instruction.
535. MODERN FOREIGN SYSTEMS OF SPORT AND PHYSICAL EDUCATION (3) Comparative analysis of national and local programs and systems of physical education in foreign countries. Prerequisites: Ph.Ed. 534, 595.
550. SEMINAR IN HEALTH AND PHYSICAL EDUCATION (1-6) An in-depth analysis of current problems confronting the profession.
555. INTERNSHIP IN SPORT ADMINISTRATION (3-10) A supervised internship in the administration of interscholastic, intercollegiate, professional sport, or commercial sport-related enterprises. Prerequisite: 14 credits in sport administration, curriculum supervision area of specialization.

560. ADMINISTRATIVE PROBLEMS OF PHYSICAL EDUCATION IN SCHOOLS (3) Solutions to problems emerging from the administration of physical education in schools, fitting physical education in the school's schedule, awards, and budgets. Prerequisite: Ph.Ed. 491.
563. MOTOR LEARNING (3) Analysis of research evidence related to motor skills; characteristics of beginning and advanced performers; relevant learning principles.
565. NEUROMUSCULAR PERFORMANCE (3) Integrative action of the neural and muscular systems in effecting human movement with emphasis on motor performance. Prerequisites: Ph.Ed. 480, 490.
567. (Phsio. 567) ADVANCED EXERCISE PHYSIOLOGY (3) Physiological changes during exercise with emphasis on the effects of physical conditioning and training. Prerequisites: Biol. 472, Ph.Ed. 480.
568. (Phsio. 568) ERGONOMICS (3) Anthropometric, biomechanical, and physiological characteristics of working man and their importance in the man-machine-environment complex. Prerequisites: Biol. 472, Ph.Ed. 480; I.E. 408 recommended for engineering students.
575. MOTOR PERFORMANCE OF THE HANDICAPPED (3) Motor performance of physically handicapped and mentally retarded. Activities and therapeutic exercises for the formulation of individualized programs. Prerequisites: Cn.Ed. 409, Spl.Ed. 410.
576. INTERNSHIP IN ADAPTED PHYSICAL EDUCATION (3) Supervised internship in recreational, educational, or clinical situations; assessment of motor performances, evaluation of activities, and staff conference participation.
577. (Phsio. 577) APPLIED CARDIOVASCULAR PHYSIOLOGY (2) In-depth study of cardiovascular system physiology. Prerequisite: 4 credits in physiology at the 400 or 500 level.
580. (Phsio. 580) ANALYSIS OF BODY COMPOSITION (2) Study of the methods employed in the analysis of body composition. Prerequisite: Biol. 472 or 3 credits in physiology at the 400 or 500 level.
581. BIOMECHANICS (3) Kinetic and kinematic analyses of human motion utilizing electromyography and stroboscopic-photographic techniques. Prerequisite: Ph.Ed. 480.
582. SPORT BIOMECHANICS (3) Analysis of sports movements utilizing cinematography, electronic devices, and related research instruments.
583. SPECIAL TOPICS IN BIOMECHANICS (1-6) Critical review of current research in biomechanics, culminating in individual research projects. Prerequisite: Ph.Ed. 581 or 582.
584. ELECTROMYOGRAPHIC KINESIOLOGY (3) The theoretical background and practical application of electromyography in understanding human movement and the function of muscles. Prerequisites: Ph.Ed. 480, 484.
585. (Phsio. 585) APPLIED PHYSIOLOGY: THERMAL (3) Physiological mechanisms activated by exposure to environmental temperature. Prerequisite: Ph.Ed. 480 or 3 credits in physiology at the 400 or 500 level.
586. (Phsio. 586) RESEARCH METHODS IN APPLIED PHYSIOLOGY (3) Historical and current procedures for evaluation of cardio-pulmonary function, metabolism, and thermal balance in man; lecture, demonstration, and student laboratory. Prerequisite: 3 credits in physiology at the 400 or 500 level.
587. (Phsio. 587) APPLIED PHYSIOLOGY: AMBIENT PRESSURE (3) Physiological mechanisms activated by exposure to environmental pressure. Prerequisite: Ph.Ed. 480 or 3 credits in physiology at the 400 or 500 level.
588. SPECIAL TOPICS IN APPLIED PHYSIOLOGY (1-6) Critical discussion and evaluation of current research in applied physiology. Prerequisite: Ph.Ed. 585.
590. COLLOQUIUM (1-3)
595. PHILOSOPHY OF SPORT AND PHYSICAL EDUCATION (3) Prerequisite: Ph.Ed. 491 or Rc.Pk. 465.
596. INDIVIDUAL STUDIES (1-6)



597. SPECIAL TOPICS (1-6)

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## PHYSICS (PHYS)

ROLAND H. GOOD, JR., *Head of the Department*  
104 Davey Laboratory  
814-865-7533

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Senior Members Barsch, Bleuler, Cole, Cutler, Feuchtwang, Fleming, Frankl, Freed, Good, Graetzer, Grotch, Henisch, Herman, Kazes, Kendall, Lang, Madjid, McCammon, McCubbin, Pliva, Polo, Pratt, Reed, Shaw, Strother, Thwaites, Tsong, Vedam, Whitfield, and Wiggins.

*Graduate Faculty:* Associate Members Chan, Lannin, Maynard, and Page.

Graduate instruction and research opportunities are available in atomic and molecular physics, nonlinear optics, field emission and field ion microscopy, many aspects of solid-state and surface physics, low-temperature physics, ionosphere and vacuum physics, acoustics, physics of biological compounds, nuclear physics, theoretical particle physics, quantum field theory, and general relativity. Work in some areas is conducted in cooperation with the Materials Research Laboratory, the Ionosphere Research Laboratory, and the Applied Research Laboratory. Thesis research toward applied options of the M.S. and the Ph.D. degrees is usually carried out in one of these laboratories.

For the Ph.D. degree, knowledge of a foreign language may be required depending on the area of research. For the M.S. and M.Ed. degrees, the nonthesis option is available subject to approval by the department head.

A bachelor's degree in physics or an allied field is required for admission to the M.S., D.Ed., and Ph.D. programs. Students with a 2.50 or higher junior-senior average in physics and mathematics will be considered, and the best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests. Exceptions may also be made for applicants for doctoral programs who have completed master's degrees at other institutions.

Admission and study programs for the M.Ed. degree are handled on an individual basis.

## PHYSICS (PHYS)

- 400. INTERMEDIATE ELECTRICITY AND MAGNETISM (4)
- 402. ELECTRONICS FOR SCIENTISTS (4)
- 406. NUCLEAR PHYSICS (3)
- 410. INTRODUCTION TO QUANTUM MECHANICS (3)
- 412. SOLID STATE PHYSICS I (3)
- 413. SOLID STATE PHYSICS II (3)
- 419. (A.M., Math. 419) THEORETICAL MECHANICS (3)
- 420. THERMODYNAMICS (3)
- 421. KINETIC THEORY AND STATISTICAL MECHANICS (3)
- 443. INTERMEDIATE ACOUSTICS (3)
- 454. ATOMIC AND NUCLEAR PHYSICS (3)
- 457. EXPERIMENTAL PHYSICS (1-2 per term)
- 458. INTERMEDIATE OPTICS (4)
- 461. (A.M., Math. 461) THEORETICAL MECHANICS (3)
- 467. INTERMEDIATE ELECTRICITY AND MAGNETISM (3)
- 471. QUANTUM THEORY OF ATOMS AND MOLECULES (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

510. GENERAL RELATIVITY (3) Foundations of general relativity; physics of metric spaces, tensor calculus; particle dynamics. Applications to stellar structure and cosmology. Prerequisites: Phys. 530; Phys. 525 or Math. 523.
511. APPLICATIONS OF GENERAL RELATIVITY (3) Einstein's equations; empty and matter-filled spaces; conservation laws; Schwarzschild, Nordström-Reissner, and Kerr solutions; solar system tests; gravitational waves. Prerequisite: Phys. 510.
- 512-513. INTRODUCTION TO THE QUANTUM THEORY OF SOLIDS (3 each) Energy band theory; electrical, optical, and magnetic properties; lattice dynamics; transport theory. Prerequisites: Phys. 412, 517.
517. STATISTICAL MECHANICS (3) Classical and quantum statistics; statistical thermodynamics; the Boltzmann transport equation; methods illustrated with applications to physical problems. Prerequisites: Phys. 420, 561.
518. ADVANCED TOPICS IN THERMODYNAMICS AND STATISTICAL MECHANICS (3) Selected topics related to nonequilibrium thermodynamics, many-body problem, fluctuations, and statistical theory of random processes. Prerequisite: Phys. 517.
524. PHYSICS OF SEMICONDUCTORS (3) Band structures, theory of electron and hole conduction, transport properties, excess carrier distributions, p-n junctions, metal-semiconductor contacts, semiconductor surfaces. Prerequisite: Phys. 412.
525. METHODS OF THEORETICAL PHYSICS (3) Vector and tensor analysis; generalized coordinate systems; matrices and linear vector spaces of finite and infinite dimensionality; calculus of variations. Prerequisite: advanced calculus.
526. METHODS OF THEORETICAL PHYSICS (3) Continuation of Phys. 525: complex variables; Hilbert space; Green's functions; orthogonal functions and boundary value problems. Prerequisite: Phys. 525.
530. THEORETICAL MECHANICS (3) Newtonian mechanics; Lagrange's equations, Hamilton's principle; Hamilton's equations; coupled systems; waves in strings, central field problem; rigid bodies; elasticity; hydrodynamics.
532. ADVANCED THEORETICAL MECHANICS (3) Least action principle, canonical transformations, Lagrange and Poisson brackets, Hamilton-Jacobi equations, classical theory of fields. Prerequisite: Phys. 530.
533. THEORETICAL ACOUSTICS (3) Vibrating systems; transmission of disturbances through elastic and viscoelastic media. Prerequisite: Phys. 530.
550. APPLIED GROUP THEORY (3) Representations of discrete and continuous groups, applications to theoretical physics and differential equations, varying emphasis on the specific applications. Prerequisite: A.M. 510 or Phys. 525.
- 553-554. NUCLEAR PHYSICS (3 each) Theory of nuclear structure and nuclear reactions; intermediate-energy nuclear theory; pion physics. Prerequisite: Phys. 562.
557. ELECTRICITY AND MAGNETISM (3) Electro- and magnetostatics, Maxwell's equations, boundary value problems, electric and magnetic properties of material media.
558. ADVANCED ELECTRICITY AND MAGNETISM (3) Energy and momentum in the field, radiation theory, classical relativistic electron theory. Prerequisite: Phys. 557.
559. GRADUATE LABORATORY (1) Introduction to techniques and instrumentation used in modern physics laboratories. Includes experience in planning experiments and working in research laboratories.
- 561-562. QUANTUM MECHANICS (3 each) The basic theory of wave and matrix mechanics, approximation methods, applications. Prerequisite: Phys. 530.
- 563-564. ADVANCED QUANTUM MECHANICS (3 each) Relativistic wave equations, quantum field theory, other advanced quantum theoretical topics. Prerequisite: Phys. 562.



571. **ATOMIC PHYSICS (3)** Experimental basis of modern physics; atomic spectra and structure, nuclear phenomena.

572. **MOLECULAR PHYSICS (3)** Electronic and nuclear motions in molecules, molecular spectra and structure. Prerequisite: Phys. 571.

596. **INDIVIDUAL STUDIES (1-6)**

597. **SPECIAL TOPICS (1-6)** (e.g., surface physics, tunneling theory, field-ion microscopy, liquid helium, superconductivity, vacuum physics, ion optics, nonlinear optics, many-body theory.)

## PHYSIOLOGY (PHSIO)

ELSWORTH R. BUSKIRK, *Chairman of the Committee on Physiology*

119 Noll Laboratory

814-865-3453

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Anthony, Bullock, Buskirk, Eberhart, Gaffney, Harrison, Hodgson, Hollis, Jefferson, Kamon, LaNoue, Leach, McCarl, Mendez, Morgan, Mortimore, Mumma, Neely, Pegg, Rose, Scholz, Senger, Wangsness, Whitfield, Wickersham, and Zelis.

*Graduate Faculty:* Associate Members Etherton, Green, Gregg, Hagen, Hawkins, Mashaly, Mitchell, Neff, Nicholas, Rannels, Schoolwerth, and Wenger.

This is an intercollege program designed to enable students to obtain an integrated series of courses encompassing both the fundamentals of physiology and advanced training in a specialized area. Courses can be taken at either The Milton S. Hershey Medical Center or at University Park.

Graduate instruction in physiology is under the direction of a program committee composed of graduate faculty representing several departments or groups at University Park actively participating in the physiology program — including the areas of animal industry, animal nutrition, biochemistry, bioengineering, biology, biophysics, physical education, psychology, veterinary science, and zoology — as well as the Department of Physiology at The Hershey Medical Center. The instructional staff is composed of faculty in those departments offering graduate courses in various areas of specialization in physiology. The program, including courses, laboratory experience, and original research, is designed for completion in three to four academic years. The communication and foreign language requirement for the Ph.D. degree may be satisfied by one of several options including intermediate knowledge of one foreign language.

Students with a 2.80 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.80 grade-point average may be made for students with special backgrounds, abilities, and interests.

Deficiencies in chemistry, mathematics (through calculus), physics, or biological science must be made up early in the student's graduate program. All candidates (master's and doctoral) must complete a general basic laboratory course in physiology (combined cellular, mammalian, and comparative) before choosing an area of specialization. Possible areas of specialization are cardiovascular and respiratory physiology; cellular and subcellular physiology; comparative physiology; environmental physiology; exercise physiology; physiology of nutrition and metabolism; neurophysiology; and reproductive physiology. The graduate committee for majors shall be appropriately represented by members of the physiology program committee and those of the area of specialization who shall have the responsibility and jurisdiction for determining the course program and research acceptable in satisfying degree requirements. The nonthesis option is available for the M.S. degree.

The following courses, among others, are available for physiology majors, and their descriptions may be found under the offerings of several departments: Agro. 512, 545; A.I. 510, 514; A.Ntr. 401, 501; Anthy. 507; Bioch. 401, 402, 417, 437, 438; Bioe. 402; Biol. 409, 428, 437, 472, 473, 479, 538, 539, 550; Cmp.Sc. 402, 410; D.Sc. 431; Ed.Psy. 400, 406, 506, 507; E.E. 569; Fd.Sc. 521; Hl.Ed. 511, 513; Meteo. 505; Micrb. 400, 401, 414, 508; M.C.B. 430, 587, 588; Nuc.E. 415, 420; Nutr. 452, 457, 458, 459, 530, 552, 557; Ph.Ed. 456, 480, 565, 586, 588; Phys. 400, 402, 420; Psy. 402, 403, 455, 503; Stat. 451, 461, 462, 464; V.Sc. 405, 418, 525, 528, 535.

The following courses in anatomy and biochemistry are offered at The Milton S. Hershey Medical Center: Anat. 501, 502, 505, 510, 512, 513, 515, 530, 535, 542, 543, 545, 550, 590, 596, 597; B.Chem. 502, 503, 504, 513, 523, 551, 553, 590, 596, 597. Descriptions of these courses may be found under the designated program.

## PHYSIOLOGY (PHSIO)

- \*520. MEDICAL PHYSIOLOGY (2) Cellular physiology including membrane permeability, bioelectric potentials, muscular contractions, secretion; metabolic physiology, including control of metabolism by hormones.
- \*521. MEDICAL PHYSIOLOGY (3) Organ physiology; examination of respiratory, renal, gastrointestinal, and cardiovascular physiology.
- \*522. PHYSIOLOGY LABORATORY (1) Practical exercises in the areas of neuromuscular physiology, metabolism, and endocrinology. Prerequisites: one year of biology, two years of chemistry, and one year of physics. Concurrent: Phsio. 520.
- \*523. PHYSIOLOGY LABORATORY (1) Practical exercises in the areas of cardiovascular, respiratory, renal, and gastrointestinal physiology. Prerequisite: Phsio. 520. Concurrent: Phsio. 521.
- \*525. GENERAL PHYSIOLOGY (2) Cellular processes of accumulation membrane transport, bioelectric potentials, contraction, and secretion in erythrocytes, nerves, sensory receptors, muscles, glands, excretory organs.
- \*530. METABOLIC AND ENDOCRINE PHYSIOLOGY (3) Regulation of carbohydrates, fatty acid, and protein metabolism; regulation of hormone secretion; effects of hormones on water and cell metabolism.
- \*532. REPRODUCTIVE PHYSIOLOGY (3) Physiology of mammalian reproductive systems, including synthesis, secretion, and mechanism of action of the steroids and polypeptide hormones involved. Prerequisites: Phsio. 520, 521.
- \*534. HEART AND SKELETAL MUSCLE (2) Discussion of structure, chemistry, and physiology of heart and skeletal muscle. Prerequisites: Phsio. 520, 521.
- \*536. GASTROINTESTINAL PHYSIOLOGY (2) Mechanisms of absorption and secretion by stomach, intestine, pancreas, and gallbladder. Neural and hormonal regulation, bioelectric potentials, pathophysiology. Prerequisite: Phsio. 521.
- 567. (Ph.Ed. 567) ADVANCED EXERCISE PHYSIOLOGY (3) Physiological changes during exercise, with emphasis on the effects of physical conditioning and training. Prerequisites: Biol. 472, Ph.Ed. 480.
- 568. (Ph.Ed. 568) ERGONOMICS (3) Anthropometric, biomechanical, and physiological characteristics of working man and their importance in the man-machine-environment complex. Prerequisites: Biol. 472, Ph.Ed. 480; I.E. 408 recommended for engineering students.
- 571. (Biol. 571) ANIMAL PHYSIOLOGY (2) Mammalian cardiovascular system; mammalian neurophysiology; excitable tissue, sensory systems, motor systems, and autonomic system. Prerequisite: Biol. 472.
- 572. (Biol. 572) ANIMAL PHYSIOLOGY (2) Mechanisms involved in the activity and control of gastrointestinal function, respiration, and renal regulation of blood and body fluids. Prerequisite: Biol. 472.
- 573. (Biol. 573) ANIMAL PHYSIOLOGY (2) Hypothalamic-hypophyseal relationships. Reproductive cycle regulation, endocrine control of fluid balance, body temperature, energy homeostasis, and metabolism of protein and minerals. Prerequisite: Biol. 472.

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\*This course is offered at The Milton S. Hershey Medical Center.



577. (Ph.Ed. 577) **APPLIED CARDIOVASCULAR PHYSIOLOGY (2)** In-depth study of cardiovascular system physiology. Prerequisite: 4 credits in physiology at the 400 or 500 level.

580. (Ph.Ed. 580) **ANALYSIS OF BODY COMPOSITION (2)** Study of the methods employed in the analysis of body composition. Prerequisite: Biol. 472 or 3 credits in physiology at the 400 or 500 level.

585. (Ph.Ed. 585) **APPLIED PHYSIOLOGY: THERMAL (3)** Physiological mechanisms activated by exposure to environmental temperature. Prerequisite: Ph.Ed. 480 or 3 credits in physiology at the 400 or 500 level.

586. (Ph.Ed. 586) **RESEARCH METHODS IN APPLIED PHYSIOLOGY (3)** Historical and current procedures for evaluation of cardio-pulmonary function, metabolism, and thermal balance in man; lecture, demonstration, and student laboratory. Prerequisite: 3 credits in physiology at the 400 or 500 level.

587. (Ph.Ed. 587) **APPLIED PHYSIOLOGY: AMBIENT PRESSURE (3)** Physiological mechanisms activated by exposure to environmental pressure. Prerequisite: Ph.Ed. 480 or 3 credits in physiology at the 400 or 500 level.

†590. **COLLOQUIUM (1-3)**

†596. **INDIVIDUAL STUDIES (1-6)**

†597. **SPECIAL TOPICS (1-6)**

## PLANT PATHOLOGY (PPATH)

SAMUEL H. SMITH, *Head of the Department*  
211 Buckhout Laboratory  
814-865-7448

*Degrees Conferred:* Ph.D., M.S., M.Agr.

*Graduate Faculty:* Senior Members Ayers, Bloom, Boyle, Cole, Davis, Kingsolver, Leath, Lukezic, MacKenzie, Merrill, P. Nelson, R. Nelson, Oswald, Pell, Schein, Schisler, Sherwood, Smith, Toussoun, and Wuest.

*Graduate Faculty:* Associate Members Frank, Hickey, MacNab, McCarthy, Pennypacker, Romaine, Royse, and Stouffer.

Plant pathology is the study of disease in plants and concerns the dynamic interaction between the plant, the causal agent (bacteria, fungi, viruses, nematodes, etc.), and their environments. A student prepares for a professional career in research, teaching, extension, or industry through advanced studies of the principles of plant infection, the physiology of disease in plants, the ecology of root diseases, the nature and inheritance of disease resistance in plants, epidemiology, ecology and physiology of air pollution injury to plants, or plant disease control by biological or chemical means. A student also may specialize in the nature and control of the diseases of forest trees, agronomic or horticultural crops, and commercial mushrooms. Advanced studies in applied mycology, related to the production of the commercial mushroom, also may be taken. Modern, well-equipped laboratories, controlled environment facilities and greenhouses, and well-developed field research areas are available for graduate study.

The Master of Agriculture degree is offered to provide professional training in plant pathology with more of a crop orientation than is available under the M.S. program. In addition to the courses required for an M.S. degree, further study in the areas of entomology and crop sciences is required. A thesis substitute, such as an internship report, or an adaptive or demonstrative activity whereby known technology or procedures are applied, is acceptable.

Competency in foreign language is not required for the Ph.D. degree; however, depending upon the nature of the thesis research and with the advice and consent of the doctoral advisory committee, competency in a foreign language may be judged to be an essential part of the doctoral studies of certain students.

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†This course is also offered at The Milton S. Hershey Medical Center.

For admission a student must present 42 credits in the natural sciences, including a minimum of 15 credits in the plant sciences and a minimum of 15 credits in mathematics, chemistry, or physics. Students with a strong background in agronomy, biochemistry, biophysics, botany, forestry, genetics, horticulture, or microbiology are usually well prepared for advanced study in plant pathology.

Students with a 2.80 junior-senior average and with appropriate course backgrounds will be considered for admission. Exceptions to the minimum 2.80 grade-point average may be made for students with special backgrounds, abilities, and interests. Students scoring in the 50 percentile or above on each section of the Graduate Record Examination will be given preference. The best-qualified applicants will be accepted up to the number of spaces and advisers that are available for new students.

## PLANT PATHOLOGY (PPATH)

- 401. THEORY AND CONCEPTS OF PLANT PATHOLOGY (3) *Merrill*
- 402. DISEASES OF ECONOMIC PLANTS (2 per term, maximum of 8) *Merrill*
- 403. INTRODUCTION TO EPIDEMIOLOGY (3) *Schein*
- 408. PLANT PATHOLOGICAL TECHNIQUES (3) *Wuest*
- 420. PLANT PATHOGENIC BACTERIA (3) *Lukezic*
- 422. INTRODUCTION TO PLANT VIROLOGY (3) *Romaine*
- 424. ENVIRONMENTAL PATHOLOGY (3) *Pell*
- 429. PHYTONEMATOTOLOGY (3) *Bloom*
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 501. CLINICAL PLANT PATHOLOGY (1-3) Diagnosis and prognosis of disease; observe and evaluate the implementation of control practices. Prerequisite: P.Path. 408. *Cole*
- 535. PRINCIPLES OF PLANT EPIDEMIOLOGY (3) Analytical methodology useful in describing pest epidemics on crop populations and the application of this information for pest control. Prerequisites: Agro. 512, P.Path. 401. *MacKenzie*
- 540. PLANT DISEASE CONTROL (3) Principles of plant disease control, including theoretical considerations involved in control by chemical and nonchemical means. *Cole*
- 541. PHYSIOLOGY OF PLANT DISEASE (3) Physiology of the diseased plant, including the host response to the pathogen and parasitic properties of the pathogen. Prerequisite: Biol. 443. *Lukezic*
- 542. EPIDEMIOLOGY OF PLANT DISEASES (4) Disease development in populations of plants, with emphasis on the impact of environment and control practices on rate of development. Prerequisite: 9 credits in plant pathology. *Pennypacker*
- 543. PATHOGEN VARIATION AND HOST RESISTANCE (3) Mechanisms and implications of genetic variation in plant pathogens related to breeding for disease resistance in plants by genetic means. Prerequisite: P.Path. 401, Agro. 411, or Hort. 407. *Ayers*
- 544. PATHOLOGICAL PLANT ANATOMY (3) Structural manifestations occurring in diseased plants. Prerequisite: Biol. 407. *P. E. Nelson*
- 560. PRINCIPLES OF PLANT PATHOLOGY (3) Open-ended discussions of concepts of plant pathology, with emphasis on their interrelationships and their significance to the science. *R. R. Nelson*
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)



## POLITICAL SCIENCE (PL SC)

JOHN D. MARTZ, *Head of the Department*  
112 Burrowes Building  
814-865-7515

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Senior Members Albinski, Aspaturian, Brown, Butterworth, Chang, Eisenstein, Friedman, Gilberg, Harkavy, Keynes, Kochanek, Martz, Myers, and Spence.

*Graduate Faculty:* Associate Members Callaghy, Cimbala, King, Murphy, O'Connor, Sarvasy, and Williams.

Candidates for the M.A. will have comprehensive examinations in one of the following fields: American politics; comparative politics; international relations: politics, organization, and law; political theory and methodology; and public administration. M.A. candidates may choose a thesis or an essay plan; both require that the student take course work in a primary and a secondary field from the above selections. Ph.D. candidates will take comprehensive examinations in three of the above fields, or in two departmental fields, and in a minor field or fields. Course work in the scope of the discipline and in methodology is required. In addition, Ph.D. candidates are required to take a graduate seminar in each of the five major fields offered. The communication and foreign language requirement for the Ph.D. may be satisfied by competence in approved skills selected from among foreign languages, statistics or mathematics, and computer science.

Students with a 3.00 junior-senior average and appropriate course backgrounds, including at least the equivalent of 12 credits in political science, will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. Applications for admission to either the M.A. or Ph.D. degree program must include transcripts, Graduate Record Examination scores (verbal and quantitative), a statement indicating career plans and proposed emphasis in political science, and at least two letters of recommendation. The applicant is responsible for soliciting letters from references. Letters of reference and the statement should be mailed directly to the department.

## POLITICAL SCIENCE (PL SC)

401. POLITICAL BEHAVIOR (3) *King and O'Connor*
403. THE LEGISLATIVE PROCESS (3) *Keynes and King*
409. QUANTITATIVE POLITICAL ANALYSIS (3) *King and Williams*
412. INTERNATIONAL ECONOMIC POLITICS (3) *Harkavy*
413. GOVERNMENT AND POLITICS OF THE SOVIET UNION (3) *Aspaturian and Gilberg*
414. FOREIGN POLICY OF THE SOVIET UNION (3) *Aspaturian*
415. INTERNATIONAL ORGANIZATION: POLITICAL AND SECURITY FUNCTIONS (3-6) *Aspaturian, Brown, Butterworth, and Harkavy*
416. INTERNATIONAL LAW (3) *Butterworth*
417. AMERICAN LOCAL GOVERNMENT AND ADMINISTRATION (3) *Friedman, O'Connor, and Williams*
418. INTERNATIONAL RELATIONS THEORY (3) *Butterworth*
419. BUREAUCRACY AND PUBLIC POLICY (3) *Callaghy, Friedman, and Williams*
420. POLICY MAKING AND EVALUATION (3)
422. COMPARATIVE URBAN POLITICS (3) *Gilberg and Myers*
425. GOVERNMENT AND POLITICS OF THE AMERICAN STATES (3) *Friedman and O'Connor*
426. POLITICAL PARTIES (3) *King and Sarvasy*
427. POLITICAL OPINION (3) *O'Connor*
431. ANCIENT AND MEDIEVAL POLITICAL THEORIES (3) *Sarvasy and Spence*
432. MODERN WESTERN POLITICAL THEORY (3) *Sarvasy and Spence*
434. CONTEMPORARY POLITICAL THEORY (3) *Sarvasy and Spence*
435. FOUNDATIONS OF AMERICAN POLITICAL THEORY (3) *Sarvasy and Spence*

436. STUDIES IN NINETEENTH- AND TWENTIETH-CENTURY AMERICAN POLITICAL THOUGHT (3) *Sarvasy and Spence*
438. NATIONAL SECURITY POLICIES (3) *Brown and Myers*
442. AMERICAN FOREIGN POLICY (3) *Brown, Butterworth, and Harkavy*
443. AMERICAN SECURITY PROBLEMS (3) *Brown and Butterworth*
444. GOVERNMENT AND THE ECONOMY (3) *Friedman and Williams*
446. THE AMERICAN LEGAL PROCESS (3) *Eisenstein, Keynes, and Murphy*
447. CONSTITUTIONAL LAW: THE FEDERAL SYSTEM (3) *Keynes and Murphy*
448. CONSTITUTIONAL LAW: DEFENDANT'S RIGHTS (3) *Keynes and Murphy*
449. CONSTITUTIONAL LAW: INDIVIDUAL AND MINORITY RIGHTS (3) *Keynes and Murphy*
450. CANADIAN AND AUSTRALIAN POLITICS AND FOREIGN POLICIES (3) *Albinski*
451. COMPARATIVE POLITICAL ANALYSIS (3) *Albinski and Martz*
452. GOVERNMENTS AND POLITICS OF EASTERN EUROPE (3) *Gilberg*
453. POLITICAL PROCESSES IN UNDERDEVELOPED SYSTEMS (3-6) *Callaghy, Chang, Kochanek, and Myers*
454. GOVERNMENT AND POLITICS OF AFRICA (3) *Callaghy*
455. GOVERNMENTS AND POLITICS OF WESTERN EUROPE (3) *Gilberg*
456. POLITICS AND INSTITUTIONS OF LATIN-AMERICAN NATIONS (3) *Martz and Myers*
457. INTERNATIONAL POLITICS OF LATIN AMERICA (3-6) *Martz and Myers*
458. GOVERNMENT AND POLITICS OF EAST ASIA (3-6) *Chang*
459. GOVERNMENT, POLITICS, AND INTERNATIONAL RELATIONS OF SOUTH ASIA (3) *Kochanek*
462. MARXIST AND SOCIALIST POLITICAL THEORY (3) *Sarvasy and Spence*
466. COMPARATIVE FOREIGN POLICIES OF WESTERN EUROPE (3) *Brown*
468. INTERNATIONAL RELATIONS OF EAST ASIA (3) *Chang*
495. POLITICAL SCIENCE INTERNSHIP (9)
496. INDEPENDENT STUDIES (1-12)
497. SPECIAL TOPICS (1-6)
499. FOREIGN STUDY — GOVERNMENT (2-6)
500. POLITICAL POWER (3-6) Subject announced prior to term offered.
509. SCOPE AND METHOD OF POLITICAL SCIENCE (3-6) *King and Williams*
512. COMPARATIVE POLITICAL SYSTEMS (3-9) *Albinski, Chang, Kochanek, and Myers*
513. SEMINAR IN COMPARATIVE POLITICAL PARTIES (3-6) Nature, function, organization, and leadership of parties; party systems, political culture, voting, and the institutional framework. *Albinski and King*
515. INTERNATIONAL POLITICS (3-6) *Butterworth and Harkavy*
516. SEMINAR IN INTERNATIONAL RELATIONS THEORY AND METHODOLOGY (3) A detailed analysis of major traditional and contemporary theory-building efforts and contemporary research techniques and orientations in international relations. *Butterworth and Harkavy*
517. INTERNATIONAL ORGANIZATION (3-6) *Aspaturian*
521. MODERN DEMOCRATIC POLITICAL THEORY (3-6) *Sarvasy and Spence*
523. SOVIET POLITICAL BEHAVIOR (3) Forces which shape rivalries for power; decision-making processes; areas of agreement and dissent. *Aspaturian and Gilberg*
524. FOREIGN POLICIES OF THE SOVIET BLOC (3-6) Major policies, the decision-making process, and the impact upon component members and external rivals for power. *Aspaturian and Gilberg*
525. COMPARATIVE AMERICAN STATE AND LOCAL POLITICS (3-6) Literature and research in comparative state and local political systems in the United States. *Friedman and O'Connor*
527. POLITICS AND LEGISLATIVE BEHAVIOR (3-6) Social factors which shape and determine the attitudes and decisions of American legislators and legislative bodies. *Keynes and King*
529. FEDERAL SYSTEMS (3-6) Features of the American federal system compared with those of other nations using the federal form. *Keynes and Friedman*



530. PUBLIC LAW (3-6) The nature of law and its role in modern society. *Eisenstein, Keynes, and Murphy*
532. EMPIRICAL POLITICAL THEORY (3-6) The impact of scientific method upon traditional political thought. *King, Spence, and Williams*
546. JUDICIAL PROCESS (3) Court functions in the political process; sources and limits of judicial power; perceptions of the judicial role; judicial decision making. Prerequisite: 12 credits in political science. *Eisenstein and Keynes*
554. AFRICAN POLITICAL SYSTEMS (3-6) Impact of European colonialism; cultural and anthropological factors in political development; modernization and analysis of selected problems in contemporary Africa. Prerequisite: 3 credits of comparative government or international relations at the 400 level. *Brown and Callaghy*
572. (Pub.A. 572) INTERNATIONAL DEVELOPMENT ADMINISTRATION (3-6) The execution of foreign policies through national and international public and private organizations. *Brown and LaPorte*
573. (Pub.A. 573) COMPARATIVE PUBLIC ADMINISTRATION (3-6) Administrative systems of selected nations on a functional basis; relationship between culture, economic and social systems, and public administration. *Callaghy, LaPorte, and Myers*
574. (Pub.A. 574) SEMINAR IN THE ADMINISTRATION OF UNITED STATES FOREIGN AFFAIRS (3) Effect of cross-cultural operations on the normal process of administration of United States foreign affairs. *Brown and LaPorte*
586. THEORY OF BUREAUCRATIC AND ADMINISTRATIVE POLITICS (3-6) The role of the executive in government and politics; theories of administrative organization, organization behavior, and decision-making processes. *Friedman and Williams*
594. READINGS IN POLITICAL SCIENCE (1-6) Directed readings in selected areas of the discipline.
595. RESEARCH IN POLITICAL SCIENCE (1-6) Directed research in selected areas of the discipline.
597. SPECIAL TOPICS (1-6)

## POLYMER SCIENCE (PLMSC)

MICHAEL M. COLEMAN, *In Charge of Graduate Program in Polymer Science*  
325 Steidle Building  
814-865-1288

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Coleman, Harrison, and Kline.

*Graduate Faculty:* Associate Members Painter and Runt.

This program offers one of the areas in which a graduate student in the Department of Materials Science and Engineering may receive an advanced degree.

Research facilities are available for studies involving the synthesis, chemical and physical characterization, and mechanical properties of polymeric materials. Special instrumentation exists for research in the areas of vibrational spectroscopy, thermal analysis, X-ray, size-exclusion chromatography, and mechanical testing. Students may plan individual programs of study; coherent interdisciplinary programs are encouraged. The nonthesis option is available for the M.S. degree.

Competency in a foreign language is not required for the Ph.D. degree. Candidates are expected to demonstrate high proficiency in both written and spoken English.

Applications will be accepted from those having degrees in the basic or applied physical sciences or in engineering disciplines. Students with a 3.00 junior-senior average normally will be considered for admission. Exceptions may be made for students with special abilities, interests, or backgrounds, such as extensive industrial experience in polymer science.

## POLYMER SCIENCE (PLMSC)

- 400. POLYMERIC MATERIALS (3)
- 406. INTRODUCTION TO THE MATERIALS SCIENCE OF POLYMERS (3)
- 407. POLYMER SCIENCE I (3)
- 409. POLYMER SCIENCE II (3)
- 410. MECHANICAL PROPERTIES OF POLYMERS AND COMPOSITES (3)
- 411. SMALL ANGLE X-RAY SCATTERING (2)
- 412. POLYMERIC MATERIALS LABORATORY — SYNTHESIS (2)
- 413. POLYMERIC MATERIALS LABORATORY — CHARACTERIZATION (2)
- 430. NATURAL POLYMERS (3)
- 490. POLYMER SCIENCE SEMINAR (1)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

520. POLYMER CRYSTALS (2) Morphology, characterization, and properties of polymer crystals. Review of electron microscopy, thermal analysis, X-ray, density, and chemical degradation studies. Prerequisite: Plm.Sc. 407 or 409.

521. POLYMER VIBRATIONAL SPECTROSCOPY I (3) The description, theory, and application of infrared and Raman spectroscopies as applied to polymeric materials. Prerequisites: Math. 240; Chem. 33 or Plm.Sc. 406.

522. POLYMER VIBRATIONAL SPECTROSCOPY II (3) The theory and application of normal coordinate analysis as applied to polymeric materials. Prerequisites: Math. 260; Cmp.Sc. 101 or 201.

562. POLYMER CHARACTERIZATION LABORATORY (2) Selected experiments in advanced characterization of polymeric materials. Prerequisite: Plm.Sc. 406.

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

## POULTRY SCIENCE (PTYSC)

KENNETH GOODWIN, *Head of the Department*  
214 Animal Industries Building  
814-865-3411

*Degree Conferred:* M.S.

*Graduate Faculty:* Senior Members Buss, Goodwin, Graves, Leach, MacNeil, and Mast.

*Graduate Faculty:* Associate Members Mashaly and Roush.

The department offers two types of degree programs: (1) an M.S. degree in poultry science, with one of the following major fields of interest: animal nutrition, behavior, food science, genetics, management, or physiology; or (2) an M.S. or Ph.D. degree in one of the following disciplinary interdepartmental programs: animal nutrition, ecology, genetics, or physiology. In either case, direction of the student's program will be by a faculty member in the Department of Poultry Science. For the Ph.D., reading ability in one foreign language is required.

Students with professional interests other than research may earn the M.S. in poultry science without doing a thesis; in this option, a paper on a selected professional problem is required for graduation.

Admission requirements include 30 credits in the biological and physical sciences (chemistry, mathematics, and physics). Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.



**POULTRY SCIENCE (PTYSC)**

- 405. POULTRY PRODUCTION TECHNOLOGY (3)
  - 462. (Biol. 462) ANIMAL BEHAVIOR — ETHOLOGY (3)
  - 463. (Biol. 463, Psy. 463) ANIMAL BEHAVIOR LABORATORY (1-2)
  - 496. INDEPENDENT STUDIES (1-12)
  - 497. SPECIAL TOPICS (1-6)
  
  - 502. POULTRY NUTRITION (2-4) *Leach*
  - 503. POULTRY FARM MANAGEMENT (3) An analysis of poultry farm management problems and the application of research methods to a specific problem.
  - 582. (Biol. 582, Psy. 582) RESEARCH IN ANIMAL BEHAVIOR (2-6 per term) Research in special areas of animal behavior involving field or laboratory work. *Graves and Hale*
  - 596. INDIVIDUAL STUDIES (1-6)
  - 597. SPECIAL TOPICS (1-6)
- NOTE: See *Animal Science* under "Other Graduate Courses and Options."

**PSYCHOLOGY (PSY)**

ROBERT M. STERN, *Head of the Department*  
 417 Moore Building  
 814-865-9514

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Borkovec, Cornwell, Craighead, Draguns, Farr, Gorlow, Guthrie, Hall, Kazdin, Landy, Leibowitz, Lundy, Mahoney, Martin, Mitzel, Nelson, Noble, Palermo, Piers, Ravizza, Ray, Seibel, Sherif, Shotland, Stern, Taylor, Thevaos, Thomas, Urban, Warren, and Weimer.

*Graduate Faculty:* Associate Members Brown, Jacobs, Mark, Newcombe, and Whaley.

Graduate instruction and research opportunities are available in the following areas of psychology: general experimental, cognition, human information processing, perception, psycholinguistics, verbal learning and memory, physiological and comparative, clinical, developmental and child, engineering and human factors, industrial-organizational, social.

The communication and foreign language requirement for the Ph.D. degree does not specify a foreign language, but a student must demonstrate proficiency in English.

Requirements for admission include a broad undergraduate preparation, a minimum of 9 credits in psychology, and a satisfactory graduate student rating on the Miller Analogies Test and the Graduate Record Examination (general and advanced). Students with a 3.40 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.40 grade-point average may be made for students with special backgrounds, abilities, and interests. Applicants with master's degrees will have their admission evaluated with emphasis on the quality of their graduate programs.

**PSYCHOLOGY (PSY)**

- 402. SENSATION AND PERCEPTION (3)
- 403. INTRODUCTORY PHYSIOLOGICAL PSYCHOLOGY (3)
- 404. CONDITIONING AND LEARNING (3)
- 405. THE EXPERIMENTAL PSYCHOLOGY OF VISUAL PERCEPTION (3)
- 408. COMPARATIVE PSYCHOLOGY (3)
- 409. TECHNIQUES IN LABORATORY EXPERIMENTATION (2-6)
- 410. HISTORICAL ANTECEDENTS OF PSYCHOLOGY (3)

411. SYSTEMS OF PSYCHOLOGY AND THE RECENT PAST (3)
  412. ABNORMAL PSYCHOLOGY (3)
  413. BIOGRAPHICAL PSYCHOLOGY (3)
  414. HUMANISTIC PSYCHOLOGY (3)
  415. INTERMEDIATE EXPERIMENTAL DESIGN (3)
  417. SOCIAL PSYCHOLOGY (3)
  418. MEASUREMENT OF PERSONALITY (3)
  419. MEASUREMENT AND SCALING (3)
  420. (Ling. 420) ADVANCED PSYCHOLINGUISTICS (3)
  421. ADVANCED COGNITIVE PSYCHOLOGY (3)
  425. CHILD PSYCHOLOGY (3)
  426. ADOLESCENCE (2-3)
  430. MEMORY AND VERBAL LEARNING (3)
  431. INDUSTRIAL PSYCHOLOGY (3)
  432. INTRODUCTORY ENGINEERING PSYCHOLOGY (3)
  434. INFORMATION-PROCESSING LABORATORY (1-6)
  435. (M.E.R. 435) ENVIRONMENTAL STIMULATION AND BEHAVIOR (3)
  436. MENTAL HEALTH IN SCHOOLS (3)
  437. PSYCHOLOGY OF ADJUSTMENT (3)
  438. THEORY OF PERSONALITY (3)
  439. (Rl.St. 439) SACRED AND PROFANE THERAPIES (3)
  441. INDUSTRIAL MOTIVATION AND MORALE (3)
  444. ATTENTION AND INFORMATION PROCESSING (3)
  445. (I.F.S. 445) DEVELOPMENT THROUGHOUT ADULTHOOD (3)
  450. (Ed.Psy. 450) PRINCIPLES OF MEASUREMENT (3)
  455. PHYSIOLOGICAL PSYCHOLOGY LABORATORY (3)
  456. LABORATORY IN PSYCHOPHYSIOLOGY (2-4)
  457. EXPERIMENTAL SOCIAL PSYCHOLOGY (4)
  463. (Biol. 463, Pty.Sc. 463) ANIMAL BEHAVIOR LABORATORY (1-2)
  470. (I.F.S. 470) SOCIAL LEARNING FOUNDATIONS OF BEHAVIOR CHANGE (3)
  471. PSYCHOLOGY AND WOMEN (3)
  474. PSYCHOLOGY OF EXCEPTIONAL CHILDREN (3)
  479. (Rl.St. 479) SEMINAR: RELIGION AND CULTURE IN FREUDIAN THOUGHT (3)
  482. INTRODUCTION TO CLINICAL PSYCHOLOGY (3)
  483. THE PSYCHOLOGY OF FEAR AND STRESS (3)
  484. CLINICAL NEUROPSYCHOLOGY (3)
  488. THE ANALYTICAL PSYCHOLOGY OF CARL JUNG (3)
  489. PSYCHOLOGY OF CONSCIOUSNESS (3)
  495. PSYCHOLOGY PRACTICUM (1-10)
  496. INDEPENDENT STUDIES (1-12)
  497. SPECIAL TOPICS (1-6)
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503. PHYSIOLOGICAL PSYCHOLOGY (2-6) Correlations between structure and function of nervous system and human consciousness; laws and theories in fields of sensation, attention, association, affection, and thought. Prerequisite: 9 credits in psychology.
  505. RESEARCH PROBLEMS IN PSYCHOLOGY (1-15) Prerequisite: 12 credits in psychology.
  510. HISTORY OF THE HIGHER MENTAL PROCESSES (3) Stress upon theoretical, conceptual, and methodological problems involved in studying human thinking, language, memory, cognition, and other skills. Prerequisite: Psy. 410 or 411.
  511. SEMINAR IN CONTEMPORARY PSYCHOLOGY (1-9) Critical review of readings on a topic of current interest, either in content or methodology, within psychology. Prerequisite: 9 credits in psychology.
  513. (Phil. 513) PRINCIPLES AND METHODS OF EMPIRICAL SCIENCE (3) Scientific methodologies and their presuppositions, with special emphasis on behavioral and social sciences.



515. **ADVANCED STATISTICS IN PSYCHOLOGY AND EDUCATION (3)** Correlation theory and methods, discriminant analysis, and factor analysis; applications to mental test theory. Prerequisite: Psy. 415 or Ed.Psy. 506.
517. **ADVANCED SOCIAL PSYCHOLOGY (3)** Problems of theory and of research methods with emphasis on persisting issues relevant to contemporary developments in social psychology. Prerequisites: Psy. 417; Psy. 15 or Stat. 200.
518. **PROJECTS IN EXPERIMENTAL PSYCHOLOGY (2-4)** Individual experimental projects; seminars on experimental design and instrumentation.
520. (Ling. 520) **SEMINAR IN PSYCHOLINGUISTICS (3)** Consideration of theoretical and research issues relevant to psychological aspects of language sounds, syntax and semantics, and other cognitive support.
522. **PERSONNEL SELECTION AND APPRAISAL (3)** Evaluation of models for personnel selection, placement, and performance appraisal in business and industry. Prerequisites: Psy. 431, Psy. (Ed.Psy.) 450.
523. **SOCIAL-ORGANIZATION PSYCHOLOGY IN INDUSTRY (3)** Analysis of the role of social and organizational variables as they affect employee performance and employee attitudes. Prerequisite: Psy. 431.
527. **STATISTICAL INFERENCE AND EXPERIMENTAL DESIGN (3)** Probability theory, sampling distributions, analysis of variance and covariance, analysis of trend, nonparametric statistics, experimental design. Prerequisite: Psy. 415 or Ed.Psy. 506.
529. (I.F.S. 529) **SEMINAR IN CHILD DEVELOPMENT (1-6)** Readings and reports on recent findings in child development. Prerequisites: 6 graduate credits in child development, child psychology, or educational psychology, plus 3 in statistics.
531. **SEMINAR IN PERFORMANCE THEORY (3-9)** Topics in theory and research on human performance in perceptual-motor and information-processing tasks. Prerequisite: Psy. 432.
533. **ADVANCED ENGINEERING PSYCHOLOGY (3)** Analysis of the role of the human operator in man-machine systems. Prerequisite: Psy. 432.
534. **PRACTICUM IN INDUSTRIAL/ORGANIZATIONAL PSYCHOLOGY (1-3)** Supervised application of psychological principles in industrial and governmental settings. Prerequisite: Psy. 431.
535. **DEVELOPMENTAL PSYCHOLOGY (2-3)** Developmental principles and concepts applied to psychological processes, with special reference to the experimental literature. Prerequisite: 9 credits in psychology.
536. (I.F.S. 536) **RESEARCH METHODS IN DEVELOPMENTAL PROCESSES (3)** Methodological issues in research on varying stages of development across the individual life-span. Prerequisites: 6 credits in individual development or psychology, and a course in statistics.
538. **PSYCHOLOGY OF PERSONNEL DEVELOPMENT (3)** Industrial training in relation to psychological learning theory and experimental findings. Prerequisite: Psy. 431 or Ed.Psy. 421.
539. **SEMINAR IN MOTIVATION AND EMOTION (3-9)** Systematic status of instinct, drive, motive, will, purpose; methodology and results of physiological, experimental, and clinical investigation of basic drives.
540. **SEMINAR IN CLINICAL PROBLEMS (1-9)** Contemporary psychological theory, research, and methodology in relation to clinical psychology. Prerequisites: Psy. 542, 560.
541. **PERSONALITY THEORY (3-4)** Contemporary theories of personality; relevant research. Prerequisite: Psy. 438.
542. **PSYCHOPATHOLOGY (3-4)** Theories of pathological behavior with reference to clinical and experimental data. Prerequisite: Psy. 412.
543. **RESEARCH DESIGN IN CLINICAL PSYCHOLOGY (3)** Experimental and quasi-experimental designs, methodological problems, and techniques of experimental control in clinical psychology research. Prerequisite: 3 credits of statistics.

544. PSYCHOLOGICAL HYPNOSIS (3) Theory and research in psychological hypnosis. Techniques in the induction and clinical applications of hypnosis.
545. SEMINAR IN VERBAL LEARNING AND VERBAL BEHAVIOR (1-9)
549. (I.F.S. 549) DEVELOPMENTAL THEORY (3) Conceptual frameworks and major contributions to the study of individual development across the life-span. Prerequisite: 6 credits at the 400 level in individual development or psychology.
555. THEORY AND PRACTICUM IN CLINICAL ASSESSMENT (3-9) Theoretical issues and research in clinical assessment with special reference to administration and interpretation of testing procedures and clinical interviewing. Prerequisites: Psy. 541 or 542, and a course in measurement.
558. CLINICAL CHILD PSYCHOLOGY (3-9) Psychopathology of childhood; theories of etiology; diagnosis and treatment. Prerequisites: Psy. 555, 561.
559. (S.Psy. 559) THE INDIVIDUAL PSYCHOLOGICAL EXAMINATION (3) Demonstrations and practice in widely used ability and aptitude tests; psychological report writing. Prerequisites: 15 credits in psychology and a course in measurement.
560. PRACTICUM IN CLINICAL METHODS (1-6) Supervised practice in the Psychology Clinic, including assessment, therapy, report writing, and staff participation. Prerequisite: Psy. 555.
561. CLINICAL PRACTICUM WITH CHILDREN (1-6) Diagnosis and counseling of child-parent problems of learning and adjustment. Prerequisites: Psy. 425, 426, 555.
563. BEHAVIOR MODIFICATION I (3) Conceptual foundations of principles, assessment methods, and research strategies.
564. BEHAVIOR MODIFICATION II (3) Survey and empirical evaluation of treatment strategies. Prerequisite: Psy. 563.
565. SEMINAR IN COMMUNITY PSYCHOLOGY (3) Application of social psychological research methods and principles to prevention and alleviation of behavior disorders in family and community settings.
566. CULTURAL PSYCHOLOGY (3) Experimental and descriptive research on culture and behavior in both Western and non-Western settings. Prerequisites: Psy. 417, 438, and 6 credits of statistics.
569. ADVANCED THEORY AND PRACTICUM IN COUNSELING AND PSYCHOTHERAPY (3-9) Theoretical issues, research, and practicum experience in psychotherapy.
571. SEMINAR IN SOCIAL PSYCHOLOGY (3-9) Historical development of theory and methods; determinants and principles of complex social or interactional behavior; contemporary problems and research.
580. THEORY AND CONSTRUCTION OF ATTITUDE SCALES (3) Measurement of social, political, commercial, and industrial attitudes; questionnaire designs. Prerequisite: 3 credits in statistics.
582. (Biol. 582, Pty.Sc. 582) RESEARCH IN ANIMAL BEHAVIOR (2-6 per term) Research in special areas of animal behavior involving field or laboratory work.
583. DESIGNING RESEARCH IN SOCIAL PSYCHOLOGY (3) Comparative analysis of major methodological approaches including laboratory experiments, field experiments, quasi-experiments, and surveys. Prerequisites: Psy. 417; 3 credits in statistics.
584. ATTITUDE FORMATION AND CHANGE (3) Theory and method in research on attitude formation and change with emphasis on critical analysis and research problems. Prerequisites: Psy. 417; 3 credits in statistics.
585. INTERACTION PROCESSES WITHIN AND BETWEEN GROUPS (3) Small group processes as context for behavior and for self system. Emphasis on theory and research in laboratory and field. Prerequisites: Psy. 417; 3 credits in statistics.
586. THE SOCIAL PSYCHOLOGY OF COLLECTIVE ACTION (3) Social movements, crowds, audiences, and large groups explored for their impact upon the behavior of the individual member. Prerequisite: Psy. 417.



- 589. PROBLEMS IN CLINICAL RESEARCH (1-6) Prerequisite: Psy. 415.
- 590. COLLOQUIUM (1-3)
- 591. SEMINAR ON TEACHING PSYCHOLOGY (1-3) Objectives and content of psychology; organization and presentation of material; teaching aids and techniques.
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)

## PSYCHOSOCIAL SCIENCE (PS SC)

JAMES R. HUDSON, *In Charge of the Graduate Program in Psychosocial Science*  
 The Capitol Campus  
 Middletown, PA 17057  
 717-948-6064

*Degree Conferred:* M.Ps.Sc.

*Graduate Faculty:* Senior Members Hudson, Lear, Masters, Nichols, and Whittaker.

*Graduate Faculty:* Associate Members Barton, Colman, Dexter, Dreiss, Hunter, Prince-Embury, and Towns.

The program emphasizes practicum experience to equip students with necessary skills to cope effectively with the problems facing communities. Graduates of the program should be able to recognize problems, to outline and implement possible solutions to these problems, and to evaluate the effectiveness of the solutions. To perform these functions the student must be aware of contemporary community needs, the impact of the community structure upon its individual members, and the techniques best suited to initiate productive change. Problems in drug abuse, delinquency, unemployment, housing, and other areas affecting the individual may be approached from a community agency base or from less formal community groups dealing with the problems.

The student is required to take 45 credits, 25 at the 500 level. The required practicum experience is field work under the supervision of a faculty member. A paper is required and will be defended orally before a committee of two faculty members and a staff member from the practicum site.

For admission, a student must have received a baccalaureate degree from an accredited institution with residence and credit conditions substantially equivalent to those required by The Pennsylvania State University. Most applicants have degrees in psychology or sociology; however, experience in community agencies is weighed for applicants from other disciplines. Ordinarily, applicants are expected to be familiar with elementary statistics and may be requested to make up any deficiency without graduate credit. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

Required courses include So.Sc. 510, 520; Ps.Sc. 470, 500, 511, 521, 530. A student may select an emphasis in public agency, community mental health, community organizing, behavioral management, or urban society. The majority of the courses are offered in the evening.

This program is offered only at Capitol Campus. Details of application procedures should be requested from Admissions, The Capitol Campus, Middletown, PA 17057.

## PSYCHOSOCIAL SCIENCE (PS SC)

- 401. SEMINAR IN PSYCHOSOCIAL SCIENCE (4)
- 407. SMALL GROUPS (4)
- 421. BEHAVIOR MODIFICATION (4)
- 461. THEORIES AND MODELS OF COUNSELING (4)
- 470. ADVANCED STATISTICAL AND DESIGN METHODS (4)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

- 500. THEORIES AND ISSUES IN COMMUNITY PSYCHOLOGY (3) Contemporary issues in community psychology will be discussed within the framework of its development from clinical and social psychology.
- 511. PSYCHOPATHOLOGY IN A SOCIAL CONTEXT (3) Psychopathology in the context of other forms of social deviancy, with attention to both social and individual concomitants of deviancy.
- 512. THEORIES AND MODELS OF PSYCHOTHERAPY (3) Survey of methods/theories used to treat mental illness or to change dysfunctional behavior. Prerequisites: Ps.Sc. 461, 511.
- 521. PRACTICUM (3-9) Experience in a field setting with problems confronting both clients and social welfare agencies. Prerequisites: So.Sc. 510, 520.
- 530. RESEARCH (1-6) Supervised research on a master's paper. For degree candidates only.
- 535. BEHAVIORAL MANAGEMENT (3) Analysis of the social determinants of behavior and behavioral ecology. Emphasis on data collection and evaluation techniques. Prerequisite: Ps.Sc. 421.
- 570. ADVANCED EXPERIMENTAL DESIGN (3) A survey of advanced statistical methods and experimental design techniques for community psychology, behavior management, and the social sciences. Prerequisites: Ps.Sc. 470, So.Sc. 520.
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)

### **SOCIAL SCIENCE (SO SC)**

- 440. THE CITY (4)
- 443. SOCIAL CONFLICT (4)
- 510. CHANGE PROCESSES (3) Social change as it takes place within institutions and communities.
- 520. TECHNIQUES IN ACTION RESEARCH (3) Methods for evaluating programmatic change. Prerequisite: So.Sc. 320.
- 531. THE FUNCTIONING NEIGHBORHOOD (3) A study of small communities and techniques for observing them, coupled with field experience in participant observation of a specific neighborhood.
- 532. COMMUNITY ORGANIZING: CONFLICT AND CHANGE (3) The development of local issues and strategies for organizing around them.
- 533. PROBLEMS OF THE DISENFRANCHISED (3) Problems confronting minority or low-power groups, with an emphasis on the poor, blacks, and women.
- 541. THE ORGANIZATION OF HUMAN SERVICES (3) Divisions of labor among social agencies; internal and external factors affecting the ordering of priorities.
- 542. SOCIAL STRATIFICATION (3) Empirical and theoretical examinations of inequalities in wealth, prestige, and power.
- 543. COMPLEX ORGANIZATIONS: CHANGE AND RESISTANCE (3) Structure and function in large organizations and case studies of change.
- 590. COLLOQUIUM (1-3)
- 597. SPECIAL TOPICS (1-6)



## PUBLIC ADMINISTRATION (PUB A)

ROBERT J. MOWITZ, *Director of the Institute of Public Administration*  
211 Burrowes Building  
814-865-2536

*Degree Conferred:* M.P.A.

*Graduate Faculty:* Senior Members LaPorte, Lee, Mowitz, and Poister.

*Graduate Faculty:* Associate Members McGowan, Stevens, and Stipak.

All candidates take a core program consisting of seven seminars which cover the theoretical, methodological, and technological components of public management science. An additional 9 credits may be elected, permitting the student to focus upon such areas as general public administration, systems analysis, management information systems, urban systems administration, natural resources administration, human resources administration, or any other related substantive area. Course work may be taken at University Park or at the Radnor Center for Graduate Studies. Admission is authorized by the University Park program director.

Candidates for admission ordinarily have at least 12 credits of undergraduate work in the social sciences. Candidates for the degree may be required to take some courses without graduate credit in order to complete a major designed for their professional needs.

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests. Scores from the Graduate Record Examination (aptitude test) and two letters of recommendation are required.

### PUBLIC ADMINISTRATION (PUB A)

- 400. INTRODUCTION TO THE AMERICAN ADMINISTRATIVE SYSTEM (3) *Mowitz*
- 402. METHODS OF PROGRAM ANALYSIS (3) *McGowan, Poister, and Stipak*
- 403. PUBLIC MANAGEMENT TECHNOLOGY (3) *LaPorte and McGowan*
- 404. URBAN MANAGEMENT (3) *Lee, Poister, and Stipak*
- 445. ADMINISTRATIVE LAW (3) *Lee and Mowitz*
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 570. ADMINISTRATION IN MULTI-JURISDICTIONAL SYSTEMS (3) Analysis of multi-jurisdictional constraints on administration; design of strategies for developing and executing programs in a pluralistic institutional setting. *LaPorte, Lee, and Poister*
- 571. THEORY OF PUBLIC ADMINISTRATION (3-6) The role of the executive in modern government; the objectives of public administration; theories of administrative organization and practice. *Mowitz, Stevens, and Stipak*
- 572. (Pl.Sc. 572) INTERNATIONAL DEVELOPMENT ADMINISTRATION (3-6) The execution of foreign policies through national and international public and private organizations. *LaPorte*
- 573. (Pl.Sc. 573) COMPARATIVE PUBLIC ADMINISTRATION (3-6) Administrative systems of selected nations on a functional basis; relationship between culture, economic and social systems, and public administration. *LaPorte*
- 574. (Pl.Sc. 574) SEMINAR IN THE ADMINISTRATION OF UNITED STATES FOREIGN AFFAIRS (3) Effect of cross-cultural operations on the normal process of administration of United States foreign affairs. *LaPorte*
- 575. GOVERNMENT MANPOWER MANAGEMENT (3) Government personnel systems; current trends and problems; essentials of recruitment, classification and pay, ratings, supervision, training, and discipline. *LaPorte, Lee, McGowan, and Stevens*

576. **GOVERNMENT FISCAL DECISION MAKING (3)** The role of the executive in fiscal planning; budget preparation; expenditure control; tax assessment and collection; investment of public funds. *LaPorte and Lee*
577. **ORGANIZATION AND SYSTEMS MANAGEMENT (3)** Principles of government organization; management surveys; work measurement; methods of achieving efficiency and economy. *Mowitz, Stevens, and Stipak*
578. **URBAN ADMINISTRATIVE SYSTEMS (3)** Urban areas as administrative and policy systems; urban responses to problems of policy planning and implementation; approaches to urban analysis. *Lee and Poister*
579. **METHODS OF ANALYSIS AND MEASUREMENT IN PUBLIC ADMINISTRATION (3 per term, maximum of 6)** Examination and application of analytical techniques for evaluating organizational performance and program effectiveness in government agencies. *Poister and Stipak*
580. **INTERNSHIP IN PUBLIC ADMINISTRATION (1-6)** *Mowitz*
581. **PUBLIC MANAGEMENT INFORMATION SYSTEMS (3)** Examination of the role of management information in public organizations; establishment of information requirements for public programs. Prerequisites: Pub.A. 571, 579. *McGowan and Stevens*
582. **LEGISLATIVE MANAGEMENT AND OVERSIGHT FUNCTIONS (3)** Examination of the role of the legislature in overseeing the executive; emphasis on financial and program analysis techniques and problems. *Mowitz*
583. **ADVANCED PROGRAM ANALYSIS (3)** Advanced research methods and quantitative techniques as applied to needs assessment and program performance evaluation of public programs. Prerequisite: 6 credits of Pub.A. 579 or other similar course work. *Poister*
584. **RESEARCH SEMINAR IN PUBLIC ADMINISTRATION (1-6)** Application of research methods to problems of organization, management, and policy in public agencies; preparation of research project and report. *Mowitz*
597. **SPECIAL TOPICS (1-6)** *Mowitz*

## PUBLIC ADMINISTRATION (P ADM)

CHRISTOPHER K. MCKENNA, *Head, Division of Public Affairs*  
The Capitol Campus  
Middletown, PA 17057  
717-948-6050

*Degree Conferred:* M.P.A.

*Graduate Faculty:* Senior Members Ferguson, Gilmore, Masters, McDermott, McKenna, and Skok.

*Graduate Faculty:* Associate Members Bresler, Chisholm, Munzenrider, Poore, and Woodruff.

The Capitol Campus M.P.A. program is approved by the National Association of Schools of Public Affairs and Administration. It is intended to prepare individuals for professional careers as administrators, project directors, or staff analysts in local, state, or federal government, health care organizations, welfare agencies, and other public service organizations. Applicants are expected to present adequate preparation in American government, college algebra, introductory statistics, economics, accounting, computer methods, and behavioral science or equivalent experience, or take work not for graduate credit in those areas.

The degree requires a minimum of 45 credits, including 9 credits of faculty-supervised field study in a public agency in the student's field of interest. The 9-credit field-study requirement may be waived for students who have at least three years of full-time professional experience in relevant administrative or staff work prior to graduation.

The 9-credit field-study course extends over three terms (about nine months) at 3 credits per term. It involves about twenty hours per week during two of the terms and about forty hours per week during the



summer term. The field study is integrated with the other course work. The location of the Capitol Campus at the state capital of Pennsylvania provides excellent opportunities for field-study experiences in state government agencies, cities and smaller municipalities, county and federal agencies, large hospitals, Penn State's Milton S. Hershey Medical Center, and other professional and public-service organizations.

Full-time graduate work is started in September, except under special circumstances. The time required to complete the program as a full-time student is normally eighteen months, including the field-study experience in a public agency.

Part-time students may start the program at the beginning of any term. They usually take one course each term but may take two courses during a term if their past academic performance is very good and their job situation permits. If a part-time student has sufficient professional work experience to waive the 9-credit field-study requirement, the graduate program can be completed in three years or less.

Students with a 3.00 junior-senior average will be considered for admission. Exceptions may be made for applicants with special backgrounds, abilities, and interests, or with professional experience. Applicants are expected to submit their aptitude scores on the Graduate Record Examination, or Graduate Management Admissions Test, a short essay outlining their career plans, and two letters of reference. The best-qualified applicants will be accepted up to the number of spaces that are available for new students.

## COURSES\*

ADMIN. 500. ADMINISTRATIVE THEORY (3)

ADMIN. 505. PERSONNEL MANAGEMENT (3)

ADMIN. 510. ORGANIZATION BEHAVIOR (3)

ADMIN. 515. LABOR MANAGEMENT RELATIONS (3)

ADMIN. 520. ADMINISTRATIVE MODELS (3)

ADMIN. 552. STATISTICAL RESEARCH METHODS (3)

P.ADM. 391G. QUANTITATIVE METHODS REVIEW FOR PUBLIC ADMINISTRATION (2) An accelerated review of selected techniques from algebra and finite mathematics applied to public management problems.

P.ADM. 393G. INTRODUCTORY GOVERNMENTAL AND NOT-FOR-PROFIT ACCOUNTING (2) Accounting concepts and techniques needed by the public administrator for financial decision making and control.

P.ADM. 440. HEALTH SYSTEMS ORGANIZATION (3) Health care policy issues, economics, planning, institutional/ambulatory care delivery, programs, manpower, technology, systems reform; public sector emphasis. Prerequisites: So.Sc. 301, 350.

P.ADM. 500. PUBLIC ORGANIZATION AND MANAGEMENT (3) Development of public administration; administrative theory and practice in public organizations. Prerequisites: 3 credits of American government, 6 credits of behavioral science, and 3 credits of micro/macro economics.

P.ADM. 501. ADMINISTRATION AND THE POLITICAL PROCESS (3) Analysis of the relationship of administration to the political processes that shape public policy formulation and execution. Prerequisites: 3 credits of American government and 3 credits of micro/macro economics.

P.ADM. 502. GOVERNMENTAL FISCAL DECISION MAKING (3) Nature, function, and technique of governmental budgeting viewed as mechanism for allocating resources among alternative public uses. Prerequisites: P.Adm. 500, 501.

P.ADM. 503. (R.PL. 500) RESEARCH METHODS (1-3) Examination of research methodologies relevant to administration, planning, and public policy. Prerequisite: 3 credits in statistics.

\*Descriptions of courses with Admin. designations can be found under that field of study.

P.ADM. 504. LEGAL AND SOCIAL CONTEXT OF PUBLIC ADMINISTRATION (3) The legal framework for public administration, the administration of public law, conduct of legal research, and socio-legal issues. Prerequisite: 3 credits in American government.

P.ADM. 520. QUANTITATIVE MODELS FOR PUBLIC ADMINISTRATORS (3) Applications of quantitative models for the administrator's viewpoint. Explanation of the underlying models, assumptions made, questions explored, without mathematical detail. Prerequisites: P.Adm. 502, 503.

P.ADM. 522. GOVERNMENT FINANCIAL MANAGEMENT (3) Theories and techniques of financial planning and control with emphasis on their application in government and nonprofit agencies. Prerequisites: P.Adm. 502 and 3 credits of accounting.

P.ADM. 524. ADMINISTRATIVE LAW (3) Statutory and judicial controls upon administrative discretion. Administration of rule making, rate setting, licensing, adjudication. Judicial review and citizen advocacy. Prerequisites: P.Adm. 500, 501, 502.

P.ADM. 530. FIELD STUDY IN PUBLIC ADMINISTRATION (1-3 per term, maximum of 9) Analysis and written reports on current problems/projects for a public agency in student's concentration area. Readings in concentration area. Prerequisite: permission of program chairman.

P.ADM. 532. URBAN GOVERNMENT (3) Administrative processes and policy problems associated with managing urban communities; political, intergovernmental, fiscal, structural, and analytical concepts in urban government.

P.ADM. 540. ADMINISTRATIVE POLICY FORMULATION (3) Analysis of administrative problems from a total organization viewpoint. Case studies of actual organizations are used for analysis.

P.ADM. 541. HEALTH ECONOMICS AND POLICY (3) Public policy issues, health system components from economic perspective. Economic analysis of health sector, medical markets, health care regulation. Prerequisites: P.Adm. 400 and introductory economics.

P.ADM. 545. HEALTH FINANCIAL MANAGEMENT (3) Theory and techniques of financial management applied to health organizations; forecasting, control systems, working capital, capital budgeting, and institutional financing. Prerequisites: P.Adm. 400, 541, and elementary accounting.

P.ADM. 546. HEALTH PLANNING FOR PUBLIC ADMINISTRATION (3) Comprehensive planning and program planning for health services, facilities, and manpower; social, economic, and political considerations; methodological problems. Prerequisites: P.Adm. 503, 541.

P.ADM. 550. PROGRAM PLANNING AND EVALUATION (3) Analysis and evaluation of public programs and systems from the perspectives of policy development and administrative planning and management. Prerequisites: P.Adm. 502, 503.

P.ADM. 554. MASTER'S PROJECT (1-3) Student independently executes an applied professional or research project, involving the analysis of a management or a public policy problem. Prerequisite: P.Adm. 503.

P.ADM. 556. STATE GOVERNMENT ADMINISTRATION (3) Study of structures, systems, processes, problems, and issues affecting state government administration; case studies, field observations, and research. Prerequisites: P.Adm. 500, 501.

P.ADM. 557. FEDERALISM AND INTERGOVERNMENTAL RELATIONS (3) Study of the impact of a federal system of government on the administration of public functions. National-state-local dimensions. Prerequisites: P.Adm. 500, 501.

P.ADM. 558. LEGISLATIVE PROCESSES (3) Legislatures in American government emphasizing comparative state legislatures: constitutional patterns; organization, administration; interaction with bureaucracy, constituencies, and organized interests. Prerequisites: P.Adm. 500, 501.

P.ADM. 590. COLLOQUIUM (1-3)

P.ADM. 596. INDIVIDUAL STUDIES (1-6)

P.ADM. 597. SPECIAL TOPICS (1-6)



## RECREATION AND PARKS (RC PK)

PATRICIA FARRELL, *Head of the Department*  
267 Recreation Building  
814-865-1851

*Degrees Conferred:* Ph.D., M.S., M.Ed.

*Graduate Faculty:* Senior Members Godbey, Lundegren, and Stoedefalke.

*Graduate Faculty:* Associate Members Chase, Christiansen, Elliott, Farrell, Guadagnolo, Howard, and Kennedy.

The graduate program is designed to prepare students for administrative, supervisory, research, and teaching positions in public and private recreation and park systems, in colleges and universities, and in voluntary agencies and institutions.

The program is oriented to meet the specific needs and research interests of the candidate. Students may pursue interests in the community, including public park and recreation systems, voluntary agencies, and private enterprises; institution and community-oriented therapeutic settings concerned with many different disabilities and utilizing a variety of activity modalities; park planning, interpretive services, outdoor education, and outdoor recreation services.

For admission to the graduate program, a bachelor's or master's degree is required, preferably in recreation and parks. Candidates from other majors are welcome to apply; however, additional course work is required. Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. In addition, a doctoral applicant should have a 3.20 average for master's degree work. Doctoral students must have at least one year's experience in the recreation and parks field before completion of their degrees. One foreign language is required for Ph.D. students, and all students must write a thesis. The Graduate Record Examination is required.

## RECREATION AND PARKS (RC PK)

- 421. WATER-ORIENTED OUTDOOR RECREATION (3)
- 425. INTERPRETIVE SERVICES (3)
- 429. INTERPRETIVE PLANNING (2)
- 430. OUTDOOR EDUCATION METHODS AND MATERIALS (3)
- 433. EVALUATION IN RECREATION AND PARKS (3)
- 434. FUNCTIONAL PLANNING AND EVALUATION OF PARK SUPPORT SYSTEMS (3)
- 435. RECREATION FACILITY PLANNING (3)
- 440. ADMINISTRATION OF ENVIRONMENTAL PROGRAM OPERATIONS (3)
- 450. RECREATION ISSUES (1)
- 458. DYNAMICS OF RECREATION GROUPS (3)
- 460. LEGAL ASPECTS OF RECREATION AND PARKS (3)
- 462. (Soc. 462) THE SOCIOLOGY OF LEISURE (3)
- 465. ADMINISTRATION OF RECREATION AND PARKS (3)
- 470. PARK MANAGEMENT (3)
- 477. THERAPEUTIC RECREATION SERVICES (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 500. (Ph.Ed. 500) INDIVIDUAL STUDY AND RESEARCH PROJECTS (1-10) Prerequisite: Rc.Pk. 530.
- 515. PROGRAM DEVELOPMENT AND SUPERVISION (3) Critical analysis of the individual, political, and societal determinants of recreation programming; demonstration projects; evaluative procedures, research functions in programming. Prerequisite: Rc.Pk. 456.
- 520. SEMINAR IN ENVIRONMENTAL EDUCATION ADMINISTRATIVE PROBLEMS (3) Focus upon use of the outdoors by special groups in resident and nonresident settings. Prerequisite: Rc.Pk. 230 or 430.

522. SEMINAR IN CURRICULUM, SUPERVISION, AND EVALUATION OF ENVIRONMENTAL EDUCATION PROGRAMS (3) Prerequisite: Rc.Pk. 430.
525. BEHAVIORAL PATTERNS OF THE OUTDOOR RECREATIONIST (3) Patterns of time and space use; user characteristics; meaning of participation; facilitation of environment-use enhancement. Prerequisite: Rc.Pk. 420.
530. (Hl.Ed. 530, Ph.Ed. 530) RESEARCH TECHNIQUES IN HEALTH AND PHYSICAL EDUCATION AND RECREATION (3) Research techniques, including methods, research design, techniques for data collection, as applied to relevant problems in the health education field.
533. RECREATION STUDIES, SURVEYS, AND APPRAISALS (3) Advanced research procedures related to special recreation and park problems. Prerequisites: Rc.Pk. 530 and 3 credits in statistics.
540. PUBLIC AND PRIVATE RECREATION LANDS AND WATERS (3) Public and private roles and interactions, allocation of resources, use policies, open space concepts, private enterprise developments, legal controls.
542. ENVIRONMENTAL LAW (3) Legislative, judiciary, administrative processes-roles; citizen action; legal concepts, litigation, and enforcement tactics for protection and enhancement of natural environment.
550. SEMINAR IN RECREATION AND PARKS (1-6)
560. ADMINISTRATIVE PROBLEMS OF RECREATION AND PARKS (3) Special problems of recreation and park departments; legal powers and liability; departmental organization, financing, personnel policies, and staff development. Prerequisite: Rc.Pk. 465.
570. CONCEPTUAL BASES FOR THERAPEUTIC RECREATION (3) Issues in the application of concepts in therapeutic recreation from a multidisciplinary perspective; evaluation and research. Prerequisite: Rc.Pk. 477.
590. COLLOQUIUM (1-3)
595. PHILOSOPHICAL AND SOCIAL BASES OF RECREATION (3) Philosophical and social bases of recreation; analysis of critical issues of recreation for philosophical and social implications.
596. INDIVIDUAL STUDIES (1-6)
597. SPECIAL TOPICS (1-6)

## REGIONAL PLANNING (R PL)

HAYS B. GAMBLE, *Chairman of the Graduate Program in Regional Planning*  
213 Willard Building  
814-865-8333

*Degree Conferred:* M.R.P.

*Graduate Faculty:* Senior Members J. Coyle, Gamble, Lee, J. Miller, Newman, Pashek, and Young.

*Graduate Faculty:* Associate Members Erickson, D. Jones, Loukissas, B. Myers, and Shirvani.

The graduate program in regional planning emphasizes a multidisciplinary approach to the planning process for multijurisdictional areas, both urban and rural. The program's basic intent is to develop technically competent regional planners who are aware of the social, political, economic, and physical purposes of planning. A strong feature of the program is that it provides a broad opportunity for a student to pursue a sequence of courses in a special option or to earn a concurrent degree in a planning-related discipline. A nonthesis option is available for the M.R.P degree. Graduates of the program are employed in planning agencies in all levels of government and in private industry.

Applicants must submit scores on the Graduate Record Examination with their applications. Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered up to the number of spaces available. Exceptions to the 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.



**REGIONAL PLANNING (R PL)**

- \*400. PRINCIPLES OF REGIONAL PLANNING (3-6)
- 410. PLANNING PROGRAMS (3)
- \*440. PROBLEMS IN COMMUNITY AND REGIONAL PLANNING (1-9)
- \*500. (P.Adm. 503) RESEARCH METHODS (1-3) Examination of research methodologies relevant to administration, planning, and public policy. Prerequisite: 3 credits of statistics.
- 502. REGIONAL SYSTEMS ANALYSIS (3-6) Spatial structure of regional and interregional systems; theories of regional development; spatial measures of location, density, central tendency, and dispersion.
- 503. THEORY AND METHOD OF PLANNING (3) Analysis of normative models of planning processes: social, economic, political, and behavioral assumptions, and methodological problems of evaluatory planning performance.
- 510. PLANNING TECHNIQUES AND ANALYSIS I (3) Regional socioeconomic structure, problems, and factors in planning; data collection, analysis, and implications.
- 520. PLANNING TECHNIQUES AND ANALYSIS II (3) Interaction of man and environment; land and water resources in regional planning; environmental factors as planning parameters.
- 530. PLANNING TECHNIQUES AND ANALYSIS III (3) Effects of political, cultural, and physical factors on planning.
- 531. PLANNING AND THE LAW (3) Sources of legal power, its transfer among governmental units; nature of regulatory power and legal constraints upon planning decision making.
- 540. PROBLEMS IN REGIONAL PLANNING (1-9) Planned individual projects involving library, laboratory (studio), or field work.
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)

**RELIGIOUS STUDIES (RL ST)**

YOSHIO FUKUYAMA, *Head of the Department*  
 1001 Liberal Arts Tower  
 814-865-3403

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Senior Members Cherry, Fukuyama, Harrison, and Prebish.

*Graduate Faculty:* Associate Members Alexander, Lowrie, Stephens, Van Herik, and Vastyan.

The emphasis of this program is on the comprehensive understanding of the various facets of religion in American culture. A broad cross-disciplinary scope is encouraged in substantive areas with particular emphasis on the development of religious thought and movements and the relationships between religion and society. The student will share responsibility with the faculty in shaping a program.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by an intermediate knowledge of two foreign languages, by substitution of courses from other designated areas for one of these languages, or by a comprehensive knowledge of one foreign language.

Applications will be evaluated on the basis of the quality of undergraduate, graduate, or professional records and on the basis of the candidate's clarity of understanding and interest in the specific emphases

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\*Offered at Capitol Campus only.

of the program. Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. Graduate Record Examination scores, letters of recommendation, and a statement of the applicant's career goals and academic interests are required.

### RELIGIOUS STUDIES (RL ST)

- 401. SEMINAR IN COMPARATIVE RELIGION (3 per term, maximum of 6)
- 402. SEMINAR IN CONTEMPORARY RELIGIOUS THOUGHT (3 per term, maximum of 6)
- 408. HINDUISM (3)
- 409. BUDDHISM (3)
- 411. SEMINAR IN JUDAISM (3 per term, maximum of 6)
- 421. CULTURE AND RELIGIOUS REFORM (3)
- 422. RELIGION AND AMERICAN CULTURE (3 per term, maximum of 6)
- 430. SEMINAR IN RELIGIOUS ETHICS (3)
- 438. (Soc. 438) RELIGION AND URBAN SOCIETY (3)
- 439. (Psy. 439) SACRED AND PROFANE THERAPIES (3)
- 461. (Soc. 461) SOCIOLOGY OF RELIGION (3)
- 479. (Psy. 479) SEMINAR: RELIGION AND CULTURE IN FREUDIAN THOUGHT (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 500. THEORIES OF RELIGION (3-6) Cross-disciplinary study of two or more systematic theories of religion: anthropological, phenomenological, philosophical, psychological, sociological, or theological.
- 502. STUDIES IN COMPARATIVE RELIGIONS (3-6) Cross-cultural comparative studies of two or more world religions.
- 505. SEMINAR IN ASIAN RELIGIONS (3-6) Studies in selected Asian religions.
- 521. ISSUES IN WESTERN RELIGION (3-6) Seminar. Study of selected issues in Western religion.
- 522. ADVANCED STUDIES IN AMERICAN RELIGION (3-6) In-depth inquiry into either a period, a movement, or a topic of American religion.
- 524. MAJOR WESTERN RELIGIOUS THINKERS (3-6) Systematic inquiry into the religious thought of major Western religious thinkers.
- 530. RELIGION AND SOCIETY (3-6) Studies of mutual influences and effects of religion and secular phenomena.
- 532. RELIGION AND SOCIAL PROBLEMS (3-6) Study of a selected social issue, or constellation of issues, with analysis of its religious and normative dimensions.
- 536. RELIGIOUS STRUCTURES AND PROCESSES (3-6) Study of the relationship between religion as social structure and as a dynamic social function.
- 539. ADVANCED STUDIES IN RELIGIOUS ETHICS (3-6) A systematic study of the structure and essential themes of ethics of religious institutions and thinkers.
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-6)
- 597. SPECIAL TOPICS (1-6)



## RURAL SOCIOLOGY (R SOC)

JOHN W. MALONE, JR., *Head of the Department of Agricultural Economics and Rural Sociology*  
6 Weaver Building  
814-865-5461

*Degrees Conferred:* Ph.D., M.S., M.Agr.

*Graduate Faculty:* Senior Members Bealer, Brown, Crawford, Malone, Stokes, Warland, Wilkinson, and Willits.

*Graduate Faculty:* Associate Members Crider, Heasley, Leadley, and Moore.

All degree programs emphasize a comprehensive understanding of the various facets of societal organization pertinent to the rural sector. While scope is encouraged, areas of special interest and research include consumer behavior, instigated social change, community structure, leadership, population, rural health, rural community services, the structure of agriculture, and the ecology of rurality in industrialized and urbanized society. All students are required to have training in sociological theory, statistics, and research methods.

There is no foreign language requirement for the Ph.D. degree; the student is expected to substitute such courses and instruction necessary to generate superior capabilities of inquiry into an analysis of basic and/or applied rural sociological problems.

Prerequisites for the master's program include 3 credits in rural sociology, 3 credits in sociology, and 3 additional credits in either field. If the entering student does not have these prerequisites, they must be made up at the University during the early part of the master's program.

Students with a 2.75 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.75 grade-point average may be made for students with special backgrounds, abilities, and interests.

## RURAL SOCIOLOGY (R SOC)

- 402. CONSUMER BEHAVIOR AND AGRICULTURAL BUSINESS (3) *Herrmann*
- 425. POVERTY ANALYSIS: PEOPLE AND PROGRAMS (3) *Van Horn*
- 444. SOCIAL CHANGE IN RURAL AMERICA (3) *Leadley*
- 452. RURAL ORGANIZATION (3) *Wilkinson*
- 459. RURAL SOCIAL PSYCHOLOGY (3) *Willits*
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 501. DEVELOPMENT OF RURAL SOCIOLOGY (2) Historical development with emphasis on American rural sociology. Odd years. *Crider*
- 502. USE OF THEORY IN RURAL SOCIOLOGY (3) Examine and evaluate metasociology of alternative theoretical systems applicable to rural society, with emphasis on American society. Prerequisite: 24 credits in sociology, including 6 in rural sociology and 3 in sociological theory. Odd years. *Bealer*
- 505. LEADERSHIP DEVELOPMENT (3) Exploration, understanding, and application of leadership roles, strategies, and principles in group and community settings. Prerequisites: R.Soc. 305; 6 credits in social or behavioral sciences. *Heasley*
- 510. RURAL MIGRATION (2) Rural migration research and theory; application to governmental and community problems. Odd years. *Stokes*
- 513. SOCIOLOGY OF CONSUMER BEHAVIOR (2) Sociological theory and research pertaining to consumer behavior. Odd years. *Warland*
- 514. VALUES IN RURAL SOCIETY (3) Relevance for policy issues of persisting cultural and value differences between rural and urban sectors of American society. Prerequisites: R.Soc. 11, 444; 6 additional credits in rural sociology. Odd years. *Bealer*

515. (Ext.Ed. 515) THE COOPERATIVE EXTENSION ORGANIZATION (3) The Cooperative Extension Service as a social system, with emphasis on techniques of organization and program development. Prerequisite: 9 credits in education, communication, and/or social sciences. *Thomson*
516. CHANGE IN RURAL SOCIETY (2) Social change in rural society, emphasizing prediction and control of the change process. Even years, *Wilkinson*; odd years, *Crider*
551. RURAL SOCIOLOGY SEMINAR (1-6) Prerequisite: 6 credits in rural sociology, sociology, or psychology.
596. INDIVIDUAL STUDIES (1-6)
597. SPECIAL TOPICS (1-6)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## SCHOOL PSYCHOLOGY (S PSY)

JOSEPH L. FRENCH, *Chairman of the Committee on School Psychology*  
104 CEDAR Building  
814-865-1881

*Degrees Conferred:* D.Ed., M.S., M.Ed.

*Graduate Faculty:* Senior Members DiVesta, French, Gorlow, Horan, Keat, Salvia, Weener, and Withall.

*Graduate Faculty:* Associate Members Berlin, Craighead, Hale, and Snyder.

This intercollege program is based primarily on courses in counselor education, educational psychology, psychology, and special education. In addition, courses are often drawn from individual and family studies, cultural foundations of education, educational administration, and curriculum and instruction.

The objective is to develop a psychologist who is interested in and knowledgeable about education and psychology in the school setting. The school psychologist must utilize professional skill and knowledge about children and youth to make contributions which are meaningful to, and utilized by, teachers, other school personnel, and parents. The development of competences needed by a fully qualified school psychologist requires at least the education represented by a doctoral degree. Only those students who anticipate a doctoral degree will be admitted. Exceptions may be made for students with special backgrounds, abilities, and interests. Students are selected within the limitations of program facilities. Priority is given to applicants with work experience with children.

An undergraduate major emphasizing work in psychology and/or education is preferred, but students with fewer than 15 upper-division credits in psychology, educational psychology, or special education may be admitted with limited deficiencies to be fulfilled concurrently with their graduate work. Requirements for admission include a minimum junior-senior scholastic average of 2.85 or, for applicants with master's degrees, a minimum of one-third of graduate credits of A quality; satisfactory recommendations from two or more professors, preferably psychologists; and 500 or higher on the general sections of the Graduate Record Examination, 58 or higher on the Miller Analogies Test, and/or 35 or higher on the Quantitative Evaluative Device.

Practicum facilities, in addition to those in nearby public schools, include the Center for Educational Diagnosis and Remediation, the School Psychology Clinic, the Speech Pathology and Audiology Clinic, the Reading Center, and the Psychology Clinic. Facilities for work with children are also available through other academic units, as well as through assistantship assignments.

The program has been accredited by the American Psychological Association, the National Commission for Accreditation in Teacher Education, and the Pennsylvania Department of Education. Students completing the School Psychology Core Program will have courses in the biological bases of behavior, the cognitive-affective bases of behavior, the social bases of behavior, personality theory, abnormal psychology, human development, professional ethics and standards, research design and methodology, statistics, psychometrics, counseling theory, educational foundations, educational administration, the education of exceptional children, and curriculum. Following the comprehensive examination, an internship is required.



**SCHOOL PSYCHOLOGY (S PSY)**

496. INDEPENDENT STUDIES (1-12)

497. SPECIAL TOPICS (1-6)

500. PROFESSIONAL ISSUES IN SCHOOL PSYCHOLOGY (1-3) Orientation to the field through study of unique problems, current issues, ethical and legal matters, unique cases, and research projects.

504. PRACTICUM IN SCHOOL PSYCHOLOGY (1-6) Clinical experience with children under supervision in a variety of settings requiring service, including practice in synthesizing data and observations.

508. INTERNSHIP IN SCHOOL PSYCHOLOGY (1-10) Long-term placement in settings providing work for school psychologists with children, parents, teachers, administrators, and service agencies, under supervision.

510. SUPERVISION OF SCHOOL PSYCHOLOGISTS (1-10) Program supervision and professional leadership in university clinics and school systems. Prerequisite: S.Psy. 504.

559. (Psy. 559) THE INDIVIDUAL PSYCHOLOGICAL EXAMINATION (3) Demonstrations and practice in widely used ability and aptitude tests; psychological report writing. Prerequisites: 15 credits in psychology and a course in measurement.

596. INDIVIDUAL STUDIES (1-6)

**SLAVIC LANGUAGES AND LITERATURES (S L L)**

WILLIAM R. SCHMALSTIEG, *Head of the Department of Slavic Languages*  
 N-440 Burrowes Building  
 814-865-1352

*Degree Conferred:* M.A.*Graduate Faculty:* Senior Members Birkenmayer, Magner, Paternost, and Schmalstieg.*Graduate Faculty:* Associate Members Gebhard and Ivanits.

Opportunities for specialization in literature or linguistics are available. A minimum requirement for admission is an undergraduate major in Russian or its equivalent.

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

The department prefers that M.A. candidates in this major submit a term paper rather than a thesis.

**RUSSIAN (RUS)**

426. DOSTOEVSKY (3)

427. TOLSTOY (3)

430. METHODS AND MATERIALS FOR TEACHING RUSSIAN (3)

450. HISTORY OF THE RUSSIAN LANGUAGE (3)

460. LINGUISTIC ANALYSIS OF CONTEMPORARY RUSSIAN (3)

496. PROBLEMS IN RUSSIAN (3-9)

\*1G. TECHNICAL RUSSIAN FOR GRADUATE STUDENTS (3) Prepares student to translate technical and scientific texts. No previous knowledge of Russian is required.

\*2G. RUSSIAN TEXTS (3) Development of skill in translating Russian texts in the sciences and social sciences. Prerequisite: Rus. 5 or 1G.

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\*No graduate credit is given for this course.

501. READINGS IN RUSSIAN LITERATURE (3-6) Prerequisite: Rus. 204.
525. PUSHKIN (3) Pushkin's significance in Russian literature; his relation to other European literatures; *Eugene Onegin* and selected shorter works.
540. EIGHTEENTH-CENTURY RUSSIAN LITERATURE (3) Study of the major writers and literary developments in this period of the secularization and modernization of Russian literature.
542. SEMINAR IN SOVIET LITERATURE (3-6) Works of representative Soviet writers; individual research in contemporary Soviet literature and literary criticism.
570. OLD RUSSIAN LITERATURE (3) Analysis of Russian literary monuments in the original, 1100-1700. Prerequisite: Slav. 550.
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## SLAVIC (SLAV)

500. BIBLIOGRAPHY AND RESEARCH TECHNIQUES (3) Tools and methods of research, designed for students preparing to do independent investigation of problems in Slavic languages and literatures.
510. STRUCTURE OF THE SOUTH SLAVIC AND WEST SLAVIC LANGUAGES (3-12; 3 credits per language) Linguistic analysis of a particular South Slavic (Bulgarian, Macedonian, Serbo-Croatian, Slovenian) or West Slavic (Czech, Lusatian, Polish, Slovak) language. Prerequisite: Rus. 460 or one graduate course in linguistics.
550. OLD CHURCH SLAVIC (3) Reading and study of that corpus of religious and liturgical documents representing the first written records of a Slavic tongue.

## SOCIOLOGY (SOC)

ROLAND J. PELLEGRIN, *Head of the Department*  
201B Liberal Arts Tower  
814-865-0172

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Senior Members Buck, Clemente, DeJong, Faulkner, Humphrey, Pellegrin, Snyder, Steffensmeier, Theodorson, and Westby.

*Graduate Faculty:* Associate Members Austin, Bord, Clogg, Gelman, Johnson, Sim, Taylor, and Walsh.

The graduate program in sociology offers advanced education for students interested in academic *and* nonacademic careers in sociology.

The M.A. and Ph.D. programs center on training in basic social theory and methodology/statistics and the empirical findings in the various areas of sociology. Major graduate programs are offered in demography, social ecology, and environmental sociology, large-scale social organizations, and social psychology. In addition, faculty research and teaching interest areas include gerontology, family, and race relations. Some course work outside the department is expected. The Department of Sociology has no formal foreign language or communication requirement. However, the student, working with his or her doctoral committee, is encouraged to pursue additional training in statistics, computer science, foreign language, technical writing, specialized methods, or specialized theory which will further dissertation and career plans. All first-year students who intend to pursue doctoral work are expected to earn an M.A. degree in their normal progress to the Ph.D. The department offers two options leading to the M.A. For the M.A. preparatory to the Ph.D., students must write a thesis and pass a candidacy examination. For the terminal M.A., students must submit a professional paper approved by a committee of three faculty members.

Undergraduate training in sociology is expected. Students of ability who are deficient in undergraduate preparation may be accepted with provisions to make up course deficiencies in the early part of their graduate program. Candidate selection is based on the following information: quality undergraduate academic performance, above-average Graduate Record Examination scores, letters of recommendation, an essay giving the applicant's interests, goals, and purposes for graduate work in sociology, and



submission of written work from the student's undergraduate program, such as a term paper. Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

The population issues program is a course of study focusing on the social, economic, and geographic policy-related issues arising from the dynamics of population trends, especially in developed nations. In addition to departmental admission requirements, the population issues committee evaluates the student's interest and aptitude for the training program, which consists of a minimum of 18 credits of interdisciplinary course work in population.

Other areas of study related to sociology, such as rural sociology, community development, cultural anthropology, developmental psychology, and political behavior, are offered in other departments of the University.

Special department-related research and training facilities include the Liberal Arts Data Laboratory, small groups research laboratory, and the Population Issues Research Center. Additional University facilities used by sociology faculty and graduate students include the Computation Center, the Inter-University Consortium of Political and Social Research, the Institute for Policy Research Evaluation, and the Gerontology Center.

## **SOCIOLOGY (SOC)**

- 400. ADVANCED GENERAL SOCIOLOGY (3)
- 401. SOCIAL INSTITUTIONS (3)
- 402. MAJOR ISSUES IN CONTEMPORARY SOCIOLOGICAL THEORY (3)
- 403. ADVANCED SOCIAL PSYCHOLOGY (3)
- 404. SMALL GROUPS (3)
- 406. SOCIOLOGICAL ANALYSIS OF DEVIANCE (3)
- 408. SOCIAL ECOLOGY (3)
- 410. SOCIAL PSYCHOLOGY OF HEALTH (3)
- 412. CRIME AND SOCIAL CONTROL (3)
- 413. METHODS AND TECHNIQUES OF SOCIAL RESEARCH (3)
- 415. THE URBAN COMMUNITY (3)
- 416. (Ed.Th.P. 416) SOCIOLOGY OF EDUCATION (3)
- 419. RACE RELATIONS (3)
- 422. HISTORY OF SOCIOLOGICAL THEORY (3)
- 423. SOCIAL DEMOGRAPHY (3)
- 424. SOCIAL CHANGE (3)
- 429. SOCIAL STRATIFICATION (3)
- 430. FAMILY IN CROSS-CULTURAL PERSPECTIVE (3)
- 432. COLLECTIVE BEHAVIOR (3)
- 435. SOCIAL GERONTOLOGY (3)
- 436. (Journ. 436) SOCIOLOGY OF OPINION FORMATION (3)
- 438. (Rl.St. 438) RELIGION AND URBAN SOCIETY (3)
- 444. COMPLEX ORGANIZATIONS (3)
- 446. POLITICAL SOCIOLOGY (3)
- 447. (M.E.R. 447) ENVIRONMENTAL SOCIOLOGY (3)
- 450. COMMUNITY ORGANIZATION (3)
- 453. (Anthy. 453) PRIMITIVE RELIGION (3)
- 454. (L.S. 454) INDUSTRY AND THE COMMUNITY (3)
- 455. (L.S. 455) THE SOCIOLOGY OF WORK (3)
- 461. (Rl.St. 461) SOCIOLOGY OF RELIGION (3)
- 462. (Rc.Pk. 462) THE SOCIOLOGY OF LEISURE (3)
- 470. INTERMEDIATE SOCIAL STATISTICS (4)
- 473. METHODS OF DEMOGRAPHIC ANALYSIS (3-6)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
- 499. FOREIGN STUDY — SOCIOLOGY (2-6)

500. SEMINAR IN GROUP THEORY (1-3) The group as a unit of social structure and action.
502. THEORIES OF SOCIETY (3) Past and present theories of the overall structure and processes of societal functioning.
503. RESEARCH SEMINAR IN SOCIAL PSYCHOLOGY (3-6) Design and conduct of research in areas of mutual interest in social psychology.
- 504-505. CURRENT SOCIAL THEORY (3 each) Current contributions to social theory; their relations to each other and to the larger theoretical structure.
506. SEMINAR IN SOCIOLOGICAL THEORY (3-9)
507. INTRODUCTION TO GRADUATE STUDY IN SOCIOLOGY (1) Required of all incoming graduate students in sociology.
510. FIELD WORK IN SOCIOLOGY (1-6)
511. READINGS IN THE SOCIOLOGY OF HEALTH (1-6) Independent pursuit of existing knowledge in fields of the student's interest, in reference books, monographs, journals. Bibliography preparation. Prerequisite: Soc. 410.
512. SEMINAR IN DEVIANT BEHAVIOR (2-6) Advanced sociological study of crime, juvenile delinquency, mental disorders, suicide, drug addiction, prostitution, and other social deviation.
- 513-514. SOCIOLOGICAL METHODS (3 each) Critical review of methodological issues; philosophy of science; research designs; analysis and interpretation of findings.
515. SEMINAR IN COMMUNITY STUDIES (3)
523. SEMINAR IN POPULATION THEORY AND POLICY (1-6) Critical review of multidisciplinary population research with an emphasis on its relation to policy issues. Prerequisite: 3 credits in population or human ecology.
525. SEMINAR IN SOCIOLOGY (1-6) Research problems in theoretical and applied sociology.
530. RESEARCH ON MARRIAGE AND THE FAMILY (3) Training in methods and techniques of research in family relations. Experimental, statistical, and comparative studies are carried out, individually or cooperatively. Prerequisite: 3 credits of previous work in this field.
- 532-533-534. SOCIAL RELATIONS (3 each) Critical appraisal of major social-psychological problems confronting modern man; emphasis on formulation of fruitful research projects and their evaluation.
535. SEMINAR IN GERONTOLOGY (2-6) A structural-functional analysis of current research dealing with the relationships between institutional structure, age grading, and social behavior.
546. SEMINAR IN POLITICAL SOCIOLOGY (3 per term, maximum of 6) Research and analysis of contemporary issues in political sociology.
551. COMPARATIVE INSTITUTIONS AND SYSTEMS OF STRATIFICATION (3) Critical appraisal of major problems in comparative sociology, including comparative studies of Western, socialist, and Third World countries.
555. INDUSTRIAL SOCIOLOGY (3) Research methods and techniques in industrial sociology; current research, unexplored areas.
- 572-573. SOCIAL STATISTICS (3 each) Application of parametric and nonparametric statistical methods to sociology; sampling; computer data processing techniques.
- 574-575. QUANTITATIVE SOCIOLOGY (3 each) Problems and issues in the mathematical and quantitative aspects of sociology.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-6)
597. SPECIAL TOPICS (1-6)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)



## SOLID STATE SCIENCE (S S S)

ROBERT E. NEWNHAM, *In Charge of Graduate Programs in Solid State Science*  
169 Materials Research Laboratory  
814-865-1612

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Barsch, Biggers, Cross, Das, Fonash, Henisch, Kline, Knox, Macmillan, Madjid, McKinstry, Mulay, Newnham, D. Roy, R. Roy, Spear, Stubican, Thrower, Tressler, Tsong, Vedam, Walker, and W. White.

*Graduate Faculty:* Associate Members Ashok, Johnson, Krishnaswamy, Messier, Scheetz, Schulze, and Vance.

The aim of this intercollege program is to provide an opportunity for the student interested in the structure, properties, and behavior of solid materials to obtain an integrated program of courses encompassing both the necessary fundamentals of chemistry, physics, and mathematics and their technological and engineering applications.

The program of courses taken by a student majoring in this program must necessarily cut across two or more disciplines. The relevant subject matter has been grouped into four areas: (1) the structure of solids (crystal chemistry and structure determination); (2) theory related to the solid state (physics, chemistry, and mechanics); (3) properties of solids (optical, electrical, magnetic, mechanical, thermal, and chemical); and (4) reactions of solids (phase equilibria, reaction mechanisms, reaction kinetics, and surface reactions).

The course work of all students will normally include the "core program" as periodically redefined. Recommended course sequences for each year for students with different undergraduate backgrounds are prepared by the chairman and are available from the student's adviser. The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of two foreign languages, or by one foreign language together with courses from other designated areas.

Entering students should hold a bachelor's degree in chemistry, physics, mathematics, geological science, engineering, ceramics, or metallurgy, or in a closely related field that will have included in it mathematics at least through integral calculus and a minimum of one year of physics and one year of chemistry. Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. The applicant should be interested specifically in an interdisciplinary program of study and research. Thesis research on various aspects of the solid state may be conducted in the Materials Research Laboratory, the Applied Research Laboratory, or in appropriate departments in the Colleges of Earth and Mineral Sciences, Engineering, and Science. The experimental facilities for research in several aspects of materials science and engineering are exceptional.

S.S.S. 590 (Colloquium) and S.S.S. 596 (Individual Studies) will be offered once each year to promote the interdisciplinary aspects of solid state science. Further information will be available from the Solid State Science office.

In addition, students may select appropriate course work from any engineering or science department. The following list includes those which are most commonly taken to satisfy core curriculum requirements: Structure of Solids: Mat.Sc. 408, 512, 514; Solid State Chemistry: Mat.Sc. 416, 501, 503; Solid State Physics: Phys. 412, 413, 524, and Cer.Sc. 508.

## SOLID STATE SCIENCE (S S S)

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-6)

## SPANISH (SPAN)

MARTIN S. STABB, *Head of the Department of Spanish, Italian, and Portuguese*  
N-352 Burrowes Building  
814-865-4252

*Degrees Conferred:* Ph.D., M.A., M.Ed.

*Graduate Faculty:* Senior Members Dalbor, Halsey, Lima, Lyday, Peavler, Pérez, Stabb, Sturcken, and Triolo.

*Graduate Faculty:* Associate Members Fitz, González-Lee, Weiss, and Zamora.

The minimum requirement for admission will normally be 24 credits of post-intermediate work in Spanish language and literature. The department may waive the requirement of a thesis for M.A. candidates in this major.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of two foreign languages or by comprehensive knowledge of one.

Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

## SPANISH (SPAN)

- 400. ADVANCED STYLISTICS (3)
- 410. ADVANCED ORAL EXPRESSION AND COMMUNICATION (3)
- 412. TRANSLATION (3)
- 413. THE TEACHING OF SPANISH (4)
- 414. SPANISH PHONOLOGY (3)
- 415. SPANISH MORPHOLOGY AND SYNTAX (3)
- 418. THE EVOLUTION OF SPANISH (3)
- 428. THE GOLDEN AGE (3 per term, maximum of 6)
- 439. DON QUIJOTE (3)
- 459. THE GENERATION OF 1898 (3)
- 472. THE CONTEMPORARY SPANISH AMERICAN NOVEL (3)
- 475. INTRODUCTION TO LATIN AMERICAN LITERATURE (3)
- 476. INTRODUCTION TO LATIN AMERICAN LITERATURE (3)
- 478. NATIONAL LITERATURE OF SELECTED HISPANIC COUNTRIES (3-9)
- 482. SPANISH LYRIC POETRY (3)
- 484. MASTERPIECES OF MODERN SPANISH DRAMA (3 per term, maximum of 6)
- 488. MASTERPIECES OF THE SPANISH NOVEL (3 per term, maximum of 6)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
- 499. FOREIGN STUDY — SPANISH (3)
  
- 502. THEORY AND TECHNIQUES OF TEACHING SPANISH (1-3) Audio-lingual orientation.
- 503. METHODS AND BIBLIOGRAPHY IN SPANISH (1-3) Methods of research; evaluation of sources and materials.
- 507. HISPANO-ROMANCE LINGUISTICS (3 per term, maximum of 9) History, development, and linguistic description of Old Spanish and related Romance languages of the Iberian Peninsula.
- 510. SPANISH DESCRIPTIVE LINGUISTICS: PHONOLOGY (3) *Dalbor*
- 511. SPANISH TRANSFORMATIONAL-GENERATIVE LINGUISTICS (3) *Dalbor*
- 514. HISPANIC DIALECTOLOGY (3) Early fragmentation among the peninsular dialects; origins and descriptive analysis of the American dialects; Judeo-Spanish. *Dalbor and Sturcken*



516. MEDIEVAL SPANISH LITERATURE (3 per term, maximum of 9) Topics vary: *juglaría* and *clerecía*, emergence of lyric and brief narrative; history and didacticism; origins of novel; balladry; fifteenth-century innovations.
518. EL LIBRO DE BUEN AMOR (3) *Sturcken*
521. THE CELESTINA AND THE LITERATURE OF THE SPANISH PRE-RENAISSANCE (3) Chief trends and works of the period of the Catholic monarchs, with special emphasis on Fernando de Rojas's masterpiece *La Celestina*. *Pérez and Triolo*
526. SIXTEENTH-CENTURY SPANISH LITERATURE (3 per term, maximum of 9) Prose and poetry of major authors: works and trends of the Renaissance and the early Golden Age. *Pérez and Triolo*
528. SEVENTEENTH-CENTURY SPANISH LITERATURE (3 per term, maximum of 9) Prose and poetry of major authors: works and trends of the late Golden Age and Baroque period. *Pérez and Triolo*
537. GOLDEN AGE THEATRE (3 per term, maximum of 6) Major works of Lope de Vega, Tirso de Molina, Calderon, and others.
540. CERVANTES (3 per term, maximum of 9) The literary works of Cervantes: Don Quijote, other novels, dramatic works, and poetry. *Pérez*
544. SPANISH ROMANTICISM (3) The major authors and works of peninsular romanticism, including poetry, drama, and prose. *Halsey and Lima*
550. SPANISH REALISM (3) The major figures of the period with special emphasis on Pérez Galdós. *Zamora*
553. WRITINGS OF THE "GENERATION OF 1898" (3 per term, maximum of 6) Novels, plays, short stories, essays, poetry of Valle-Inclán, Azorín, Benavente, Unamuno, Machado, Maeztu, and Maroja in the context of generation concept.
560. THE CONTEMPORARY NOVEL IN SPAIN (3) The novel since 1941: Cela, Laforet, Zunzunegui, Suárez Carreño, Matute, and others. *Zamora*
563. CONTEMPORARY DRAMA IN SPAIN (3) The drama from 1898 to the present day: Benavente, Valle-Inclán, García Lorca, Casona, Buero Vallejo, Sastre, and others. *Halsey and Lima*
566. CONTEMPORARY SPANISH POETRY (3) Various currents in Spanish poetry from the generation of 1927: Lorca, Aleixandre, Salinas, Guillén, Alonso, Alberti, Hernández, Otero, and others. *Staff*
568. EARLY SPANISH AMERICAN LITERATURE (3 per term, maximum of 9) Content varies; selected topics from colonial period, romanticism, and the nineteenth century before modernism. *Staff*
570. MODERNISMO (3) The movement, its antecedents, and its followers, with special emphasis on Rubén Darío. *Staff*
574. THE SPANISH AMERICAN NOVEL (3 per term, maximum of 9) Content varies; selected works from the late nineteenth century through the contemporary period. *Peavler*
575. THE SPANISH AMERICAN ESSAY (3) Tracing the history of ideas in Spanish America through major essayists. *Stabb*
576. TWENTIETH-CENTURY SPANISH AMERICAN POETRY (3) Influential poets and literary movements after *Modernismo*. *Lyday and Stabb*
577. SPANISH AMERICAN DRAMA (3) Dramatic literature in Spanish America from colonial times to the present. *Lyday*
581. THE SPANISH AMERICAN SHORT STORY (3) Critical analysis of the major writers and movements from Echeverría to the present. *Lyday, Peavler, and Stabb*
587. STYLISTIC AND LITERARY CRITICISM (3) Major theories of literary criticism applied to Hispanic literature.
588. SEMINAR IN HISPANIC LITERATURE (3-12) Common and individual research in special problems in Spanish or Spanish American literature.

## SPECIAL EDUCATION (SPLED)

G. P. CARTWRIGHT, *In Charge of Graduate Programs in Special Education*  
327 CEDAR Building  
814-863-2286

*Degrees Conferred:* Ph.D., M.S., M.Ed.

*Graduate Faculty:* Senior Members C. Cartwright, G. Cartwright, French, Neisworth, Salvia, and Tawney.

*Graduate Faculty:* Associate Members Abbott, Gajar, Goodman, Hane, Mann, McAfee, Price, and Sindelar.

Exceptional children are those who deviate so far from average in physical, intellectual, emotional, or social characteristics that they cannot profit adequately from the usual public school program. It is the purpose of this program to prepare teachers, researchers, and college and university teachers in the areas encompassing the education of the mentally retarded, gifted, emotionally disturbed, neurologically impaired, or learning disabled. A multidisciplinary approach is emphasized. The communication and foreign language requirement for the Ph.D. degree may be satisfied by options selected from designated areas including, but not restricted to, foreign languages.

Prerequisites for a master's program include 21 credits basic to the education of exceptional children (courses comparable to Spl.Ed. 400, 401, 454, 495a; Spl.Ed. 410 or 430 or 470; Mth.Ed. 420; RCLEd. 400; a 400-level course in child development or child psychology; and a 400-level course in foundations of education).

Highest admission priorities are given to applicants who possess certification in special education or elementary education. Applicants for master's and doctoral programs must present evidence of superior academic achievement and aptitude, complete a personal statement, present Graduate Record Examination (GRE) verbal and quantitative test scores, or Miller Analogies Test (MAT) scores, and provide professional references. Minimum test scores of master's and doctoral applicants respectively are GRE (verbal and quantitative combined), 900 and 1100; MAT, 35 and 50. Applicants for doctoral study must have had at least two years of relevant experience with handicapped children. Applicants from foreign countries must submit TOEFL (Test of English as a Foreign Language) scores. Exceptions to the admissions criteria may be made only for highly qualified students with special backgrounds, abilities, and interests.

## SPECIAL EDUCATION (SPLED)

- 400. INTRODUCTION TO EXCEPTIONAL CHILDREN (3)
- 401. EDUCATIONAL ADJUSTMENTS FOR EXCEPTIONAL CHILDREN (3)
- 402. HUMAN RIGHTS FOR THE HANDICAPPED STUDENT (2)
- 404. PARENTS AS TEACHERS (2)
- 410. THE MENTALLY RETARDED (3)
- 411. INSTRUCTION FOR THE SEVERELY HANDICAPPED (3)
- 412. INSTRUCTION FOR THE MILDLY HANDICAPPED STUDENT (3)
- 413. (Voc.Ed. 413v) VOCATIONAL EDUCATION FOR SPECIAL-NEEDS LEARNERS (3)
- 415. EARLY SPECIAL EDUCATION (3)
- 420. THE MENTALLY GIFTED (3)
- 430. LEARNING DISABILITIES (3)
- 440. (Cm.Dis. 440) SURVEY OF SPEECH AND HEARING DISORDERS (3)
- 454. DIAGNOSIS OF EDUCATIONAL DISABILITIES (3)
- 460. EDUCATION OF VISUALLY HANDICAPPED CHILDREN (1)
- 470. THE EMOTIONALLY DISTURBED (3)
- 472. EDUCATIONAL PROBLEMS OF ALIENATED YOUTH (3)
- 495a. CLINICAL TEACHING WITH EXCEPTIONAL CHILDREN (3)
- 495b. PRACTICUM IN THE EDUCATION OF EXCEPTIONAL CHILDREN (1-12)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)



500. SEMINAR IN SPECIAL EDUCATION (1-9) Continuing series of professional seminars designed to provide a forum for discussion of current and classical research concerning exceptional children. Prerequisites: Ed.Psy. 400 and 6 credits in education of exceptional children.
501. ADMINISTRATION AND SUPERVISION OF EDUCATIONAL PROGRAMS FOR EXCEPTIONAL CHILDREN (2-3) Problems connected with the instituting and organizing of classes for atypical children; the legal phases, finances, teaching personnel, pupil personnel, housing, equipment, courses of study, curriculum, etc. Prerequisites: Spl.Ed. 401 and Ed.Adm. 480, or teaching or administrative or supervisory experience.
502. INTERNSHIP IN SPECIAL EDUCATION (2-10) Internship to take place in schools or educational situations where student is not regularly employed, under supervision of graduate faculty. Prerequisite: Spl.Ed. 495b or teaching experience.
505. PRACTICUM (1-6) Supervised clinical experience on campus in University-managed diagnostic and remedial settings.
506. FIELD EXPERIENCES IN OFF-CAMPUS LABORATORIES (1-10) Supervised off-campus field experiences in selected laboratory settings with exceptional children. Prerequisite: Spl.Ed. 505.
507. INTERNSHIP IN SPECIAL EDUCATION SUPERVISION (1-6) Internship in day/residential school setting under supervision of field supervisor and University faculty. Prerequisite: Spl.Ed. 506.
510. PROBLEMS IN THE EDUCATION OF THE MENTALLY RETARDED (2-4) Study of existing curriculums, instructional practices, educational programs; experimentation in curriculum building and materials construction. Prerequisites: teaching experience and Spl.Ed. 410.
520. PROBLEMS IN THE EDUCATION OF THE MENTALLY GIFTED (2-4) Analysis of educational needs of the mentally gifted; curriculum construction and curricular materials. Prerequisites: teaching experience and Spl.Ed. 420.
530. PROBLEMS IN THE EDUCATION OF THE LEARNING DISABLED (2-4) Review of the research and theoretical implications in the educational and behavioral management of learning disabled children. Prerequisite: Spl.Ed. 430.
547. (Cm.Dis. 547) LANGUAGE DISORDERS IN CHILDREN (2) Nature, etiology, diagnosis, and management of language disorders in children. Prerequisite: 9 credits in speech pathology and audiology or related fields such as psychology, linguistics, or human development.
554. PSYCHOLOGICAL AND EDUCATIONAL EVALUATION OF EXCEPTIONAL CHILDREN (3) Administration and interpretation of individual tests other than the Stanford-Binet, WISC, WAIS. Prerequisite: Psy. 559.
570. PROBLEMS IN THE EDUCATION OF THE EMOTIONALLY DISTURBED (2-4) Prerequisite: Spl.Ed. 470.
572. SEMINAR IN THE EDUCATION OF ALIENATED GROUPS (2) A study of the alienated and educational issues of coping with problems of social, cultural, and economic deprivation. Prerequisite: Spl.Ed. 472.
573. PROBLEMS OF RESEARCH WITH ALIENATED GROUPS (2) A seminar to review and design research studies for the education and training of alienated groups. Prerequisites: Spl.Ed. 472, 572.
596. INDIVIDUAL STUDIES (1-6)
597. SPECIAL TOPICS (1-6)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## SPEECH COMMUNICATION (SPCOM)

ROBERT S. BRUBAKER, *Head of the Department*  
212 Sparks Building  
814-865-3461

*Degrees Conferred:* Ph.D., M.A.

*Graduate Faculty:* Senior Members Benson, Brubaker, Cohen, Gilbert, Gregg, Hauser, Paulson, Phillips, and White.

*Graduate Faculty:* Associate Members Barton, Butt, Christenson, De Boer, Dunham, Hirokawa, Lindlof, Mander, Pedersen, and Zawadzki.

The student may specialize in speech arts (interpretation, drama, theatre); radio and television; rhetoric and public address (including discussion, communication, teaching of speech); speech science (voice, diction, phonetics, general semantics); and communicative theory. A thesis is required of all M.A. candidates in this major.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by options selected from designated areas including, but not restricted to, foreign languages.

The minimum undergraduate preparation required is 12 credits in speech. Students who cannot meet this requirement in full may be admitted but must make up their deficiencies without credit toward the graduate degree. Sp.Com. 400 and 502 are required of all graduate students who do not have their equivalents.

Students with a 3.00 junior-senior average, with scores on the Graduate Record Examination (general), and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

## SPEECH COMMUNICATION (SPCOM)

\*115G. ENGLISH AS A SECOND LANGUAGE (3-15) Development of communicative competence using spoken and written English. Intensive (full-time), intermediate, or advanced sections according to diagnostic test results.

- 400. TEACHING OF SPEECH (3)
- 402. SPEECH AND HUMAN BEHAVIOR (3)
- 403. INTERPERSONAL ORAL COMMUNICATION THEORY (3)
- 410. AMERICAN-ENGLISH PHONETICS (3)
- 412. SPEECH CRITICISM (3)
- 413. (Ling. 413) EXPERIMENTAL LINGUISTICS (3)
- 415. RHETORIC OF FILM AND TELEVISION (3)
- 417. DIRECTING FORENSICS (3)
- 419. (Journ. 419) COMPARATIVE BROADCASTING SYSTEMS (3)
- 420. SYSTEMS AND THEORIES OF RHETORIC (3)
- 425. RADIO PROGRAMMING AND PERFORMANCE (3)
- 431. ANATOMY AND PHYSIOLOGY OF THE VOCAL MECHANISMS (3)
- 435. RADIO AND TELEVISION PROGRAMMING (3)
- 437. TELEVISION PROGRAMMING AND PERFORMANCE (3)
- 440. SYSTEMS AND THEORIES OF HUMAN COMMUNICATION (3)
- 450. THEORY AND PRACTICE OF GROUP COMMUNICATION (3-6)
- 455. GENDER ROLES IN COMMUNICATION (3)
- 470. NONVERBAL COMMUNICATION (3)

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\*No graduate credit is given for this course.



475. PERSUASIVE CAMPAIGNS (3)
478. CONTEMPORARY AMERICAN POLITICAL RHETORIC (3)
481. (L.A. 481) COMPUTER APPLICATIONS TO COMMUNICATIONS STUDIES (3)
485. ADVANCED ORAL INTERPRETATION OF LITERATURE (3)
490. PSYCHOLOGY OF SPEAKING AND LISTENING (3)
492. DEVELOPMENT OF COMMUNICATION BEHAVIOR IN CHILDREN (3)
494. TEACHING OF ENGLISH AS A SECOND LANGUAGE (3)
495. COMMUNICATION INTERNSHIP (1-9)
496. INDEPENDENT STUDIES (1-12)
497. SPECIAL TOPICS (1-6)
499. (Journ. 499) FOREIGN STUDY — MASS COMMUNICATIONS (1-9)
500. SEMINAR IN AMERICAN ORATORY (2-6) History of American oratory with application of critical standards to the work of specific orators.
502. RESEARCH METHODS IN SPEECH (3) Research design, thesis proposals, and background for research in graduate study. Prerequisite: 6 credits at the 400 or 500 level in speech communication, clinical speech, or theatre arts.
503. SEMINAR IN CRITICISM (3) Study of philosophies and methods available for the critical analysis of rhetorical transactions. Prerequisite: Sp.Com. 412.
505. HISTORICAL DEVELOPMENT OF SPEECH THEORY AND CRITICISM (2-4) Classical theories of speech making from the earliest beginnings to the fall of the Roman Empire.
506. HISTORICAL DEVELOPMENT OF SPEECH THEORY AND CRITICISM (2-4) Theories of speech making from the Renaissance to the present.
507. CONTEMPORARY RHETORICAL THEORY (2-4) A study of rhetorical theory from 1930 to the present, focusing on semantic, political, sociological, symbolic, and philosophical perspectives. Prerequisites: Sp.Com. 412, 505 and/or 506.
508. SEMINAR IN BRITISH ORATORY (2-4) History of British oratory; application of critical standards to the work of selected orators.
509. PROBLEMS IN RHETORIC AND ORATORY (2-6) Comparative study of selected orators and rhetoricians. Prerequisite: 6 credits in speech communication.
510. PROBLEMS IN SPEECH EDUCATION (2-4) Advanced knowledge, theories, and principles, together with their philosophical, scientific, clinical, artistic, and educational implications for the teacher of speech. Prerequisites: Sp.Com. 502 and 9 additional credits at the 400 or 500 level in speech communication, clinical speech, or theatre arts.
520. SEMINAR IN SPEECH SCIENCE (3-6) Seminar in physical and physiological bases of speech and voice; introduction to laboratory techniques used in speech research. Prerequisite: 9 credits in speech communication, speech pathology and audiology, or psychology.
522. (Cm.Dis. 522) SPEECH PERCEPTION (3) Transformation of linguistic units into acoustic speech signals, theories of speech perception, and auditory processing of the speech signal. Prerequisites: Sp.Com. 410, 431, 520.
530. POLITICAL MEDIA (3) Study of research, theory, and selected cases of political communication in the broadcast media.
540. SEMINAR IN PROBLEMS OF TELEVISION AND RADIO (2-4) Study and research in television and radio as they pertain to programming, production, relation to society, and speech.
550. SEMINAR IN ORAL PERSUASION (2-4) Theory and devices of persuasion; analysis of persuasive discourse. Prerequisite: 6 credits in speech communication including Sp.Com. 200.
552. ORAL COMMUNICATION IN INDUSTRY, BUSINESS, AND GOVERNMENT (2-4) Needs, practices, and methods in American industry, business, and government; methods of training adults in oral communications skills.

554. SEMINAR IN SMALL GROUP COMMUNICATION (2-4) Communication variables in small groups. Experimental research and innovations in communication in vocational, therapeutic, and educational groups.

555. SPEECH COMMUNICATION: PROBLEMS AND PRINCIPLES (2-6) Prevalent theories of speech influence.

575. RESEARCH PROBLEMS IN SPEECH (1-9) Advanced research on an individual basis in oratorical criticism, discussion techniques, persuasion, pedagogy, phonetics, speech science, and speech pathology. Prerequisite: 12 credits in speech communication or speech pathology and audiology.

590. COLLOQUIUM (1-3)

597. SPECIAL TOPICS (1-6)

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## STATISTICS (STAT)

WILLIAM L. HARKNESS, *Head of the Department*  
219 Pond Laboratory  
814-865-1348

*Degrees Conferred:* Ph.D., M.S., M.A.

*Graduate Faculty:* Senior Members Antle, Bartoo, Haight, Harkness, Hettmansperger, Hultquist, Patil, and Ryan.

*Graduate Faculty:* Associate Members Arnold, Boswell, Clogg, Lindsay, Lynch, and Rosenberger.

Graduate instruction and research opportunities are available in most areas of statistics and probability, including linear models, nonparametric statistics, robustness, statistical computing, analysis of count data, multivariate analysis, experimental design, reliability, stochastic processes and probability (applied and theoretical), distribution theory, statistical ecology, and biometrics.

The opportunity is also available for students to gain practical experience by participating, for academic credit, in the department's consulting and collaborative research program.

For the M.A. degree the candidate must complete 30 course credits, with at least 18 credits (12 in statistics) of 500-level courses; 3 credits in probability (Stat. 409); 6 credits of mathematical statistics (Stat. 410 and 412); 3 credits in computer science, Math. 441 or 481; 3 credits in seminars and/or individual studies; and 6 credits in an approved area. In addition, the M.A. candidate must submit a master's paper. The requirements for the M.S. degree are the same as for the M.A., except that 6 credits of thesis research replace an equal number of course credits, and a thesis is required rather than a master's paper.

The department administers a master's and Ph.D. qualifying examination which all students in the program must take. This examination is intended to be taken early in the program and Ph.D. candidacy is contingent on successful completion of the examination.

After admission to candidacy, each Ph.D. candidate is required to pass two comprehensive examinations. One must be in mathematical statistics and the other in an area to be selected by the candidate, subject to the approval of the faculty. There is no foreign language requirement for the Ph.D. in statistics. Every Ph.D. candidate is required to perform various services in addition to formal course work. If feasible, they all must gain teaching experience, be involved in statistical consulting (here at Penn State with other graduate students or non-statistics faculty), and carry out research for the Ph.D. degree.

While applications from all students (including those who already have done graduate work) are reviewed, completion of a standard calculus sequence is regarded as a prerequisite. Students with a 3.00 or better junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.



The department requires the verbal and quantitative scores on the Graduate Record Examination (GRE) from those applicants who wish to be considered for financial support. The Graduate School requires all applicants for admission to submit the GRE scores.

Entering graduate students in statistics for whom English is not the first language are required to have a score of at least 550 on the TOEFL (Test of English as a Foreign Language) examination. The results of this examination must be received by the Department of Statistics at least six months prior to the requested date of admission to the Graduate School.

Students in the statistics program may elect the dual-title degree program option in operations research for the Ph.D. and M.S. degrees (see p. 249).

## STATISTICS (STAT)

- 401. EXPERIMENTAL METHODS I (3)
- 402. EXPERIMENTAL METHODS II (3)
- 409. (Math. 409) INTRODUCTION TO PROBABILITY THEORY (3)
- 410. (Math. 410) MATHEMATICAL STATISTICS I (3)
- 412. (Math. 412) MATHEMATICAL STATISTICS II (3)
- 418. (A.M. 418, Math. 418) DISCRETE PROBABILITY THEORY (3)
- 427. (Math. 427) DISCRETE STOCHASTIC MODELS (3)
- 451. INTRODUCTION TO APPLIED STATISTICS (3)
- 460. INTERMEDIATE STATISTICAL METHODS (3)
- 461. SAMPLING METHODS (3)
- 462. APPLIED REGRESSION ANALYSIS (3)
- 464. APPLIED NONPARAMETRIC STATISTICS (3)
- 480. INTRODUCTION TO STATISTICAL PROGRAM PACKAGES (1)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
- 501. REGRESSION ANALYSIS AND MODELING (3) Use of simple and multiple regression and correlation to analyze research data; dummy variables, step-wise and non-linear regression. Prerequisites: 6 credits in statistics or Stat. 451; matrix algebra.
- 502. ANALYSIS OF VARIANCE AND DESIGN OF EXPERIMENTS (3) Experimental design and analysis; fixed, mixed, and random effects models; covariance analysis; multiple comparisons; repeated measures; unbalanced data; computer techniques. Prerequisite: 6 credits in statistics.
- 503. DESIGN OF EXPERIMENTS (3) Design principles; optimality; confounding in split plot, repeated measures, fractional factorial, response surface, and balanced/partially balanced incomplete block designs. Prerequisites: Stat. 502; Stat. 462 or 501.
- 504. ANALYSIS OF CATEGORICAL DATA (CONTINGENCY TABLES) (3) Classical analysis of multi-factor contingency tables; linear and log-linear models; measures of association; graphical methods. Prerequisites: 6 credits in statistics, matrix algebra.
- 505. APPLIED MULTIVARIATE STATISTICAL ANALYSIS (3) Analysis of multivariate data;  $T^2$ -tests; partial correlation; discrimination; MANOVA; cluster analysis; regression; growth curves; factor analysis; principal components; canonical correlations. Prerequisite: 6 credits in statistics.
- 506. SAMPLING THEORY (3) Theory and application of sampling from finite populations. Prerequisite: 6 credits in statistics.
- 509. DISCRETE STATISTICAL MODELS AND METHODS (3) Systematic study of probability models and statistical methods pertaining to statistical analysis of data consisting of single and multiple counts. Prerequisites: Stat. 410, 542.
- 510. APPLIED TIME SERIES ANALYSIS (3) Identification of models for empirical data collected over time. Use of models in forecasting. Prerequisite: Stat. 462 or 501.
- 512. (A.M. 512) INTRODUCTION TO STOCHASTIC PROCESSES (3) Markov chains, random walk and recurrent events, queuing theory, time-dependent stochastic processes. Prerequisite: Stat. (Math.) 409 or Stat. (A.M., Math.) 418.

513. (A.M. 513) INTRODUCTION TO STOCHASTIC PROCESSES (3) Markov chains, random walks and recurrent events, queuing theory, time-dependent stochastic processes. Prerequisite: Stat. (A.M.) 512.
- 517-518. (Math. 517-518) PROBABILITY THEORY (3 each) Measure theoretic foundation of probability, distribution functions and laws, types of convergence, central limit problem, conditional probability, special topics. Prerequisites: Math. 452, 501.
524. ECOMETRICS (3) Stochastic models and statistical methods in ecological problems; population dynamics, spatial patterns in populations of one, two, or more species. Prerequisite: Stat. 409 or 418.
534. (M.E.R. 534) DYNAMIC PROGRAMMING (3) The study of the concepts underlying model-building and optimization of dynamic systems; applications to engineering, economic, and environmental systems. Prerequisites: Stat. 418; I.E. 405 or Q.B.A. 451.
542. (Math. 542) STATISTICAL DISTRIBUTION THEORY IN SCIENTIFIC WORK: I. DISCRETE MODELS (3) Statistical distributions arising in scientific modeling and statistical inference; structures, interrelations, characterizations, and simulation with practical examples. Prerequisites: Stat. (Math.) 410; knowledge of matrix algebra.
543. (Math. 543) STATISTICAL DISTRIBUTION THEORY IN SCIENTIFIC WORK: II. CONTINUOUS MODELS (3) Statistical distributions arising in scientific modeling and statistical inference; structures, interrelations, characterizations, and simulation with practical examples. Prerequisite: Stat. (Math.) 542.
551. LINEAR MODELS I (3) Statistical distribution theory of quadratic forms and linear transformations; full-rank estimation; regression; response surfaces; Cochran's theorem. Prerequisites: Stat. 502; Math. 441 or 481.
552. LINEAR MODELS II (3) Non-full-rank statistical inference, interaction, variance components, covariance analysis, cross, hierarchical and incomplete classification theory and methodology. Prerequisite: Stat. 551.
561. STATISTICAL INFERENCE I (3) Multiparameter estimation; linear estimation; maximum likelihood estimation; Bayesian estimation; large sample properties and procedures. Prerequisite: Stat. 410.
562. STATISTICAL INFERENCE II (3) Testing statistical composite hypotheses; invariance principles; Bayesian statistics; large sample properties and procedures. Prerequisite: Stat. 561.
564. NONPARAMETRIC STATISTICS: THEORY (3) Estimation and testing based on nonparametric procedures for location and regression models. Distribution theory and asymptotic efficiency. Prerequisites: Stat. 410 and 3 additional credits in statistics.
565. THEORY OF MULTIVARIATE STATISTICAL ANALYSIS (3) Multivariate normal, Wishart and related distribution; Hotelling's  $T^2$  and Cochran's theorem; classification; growth curves; cluster analysis; factor analysis. Prerequisite or concurrent: Stat. 505. Prerequisites: Stat. 410; Math. 441 or 481.
572. STATISTICAL DECISION THEORY I (3) Structure of statistical games; optimal strategies, fixed sample-size games. Prerequisite: Stat. 410.
580. STATISTICAL CONSULTING PRACTICUM (2 per term, maximum of 10) General principles of statistical consulting and statistical consulting experience. Preparation of reports and other aspects of consulting. Prerequisites: Stat. 462 or 501; Stat. 502; Stat. 503 or 504 or 505.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-6)
597. SPECIAL TOPICS (1-6)



## TEACHING AND CURRICULUM (T & C)

ROBERT LESNIAK, *In Charge of the Graduate Program in Teaching and Curriculum*

The Capitol Campus  
Middletown, PA 17057  
717-948-6213

*Degree Conferred:* M.Ed.

*Graduate Faculty:* Senior Members Allison, Lear, and Swetz.

*Graduate Faculty:* Associate Members Alexander, Ammon, Barnes, Chant, Eisenstein, Lesniak, Miller, Smith, Susskind, and Towns.

The Master of Education in Teaching and Curriculum at Capitol Campus provides to full-time and part-time students a curriculum designed to develop master teachers for public and private school instruction and to develop education specialists (teaching certification not required) for the areas of business, industry, government, medicine, and other social services. In addition, specialties are available in particular areas, such as reading, urban education curriculum, early childhood education, elementary education, and secondary English, social studies, and mathematics education.

Specifically, the goals of the program are to develop in students (1) the ability to communicate effectively either with school-aged students and their parents or with co-workers and/or clients; (2) the ability to conduct an instructional program which provides a sound intellectual and emotional climate for learning; (3) competence in a variety of teaching methods and in the utilization of materials and content appropriate for an effective instructional program; (4) the ability to interpret and to evaluate educational literature and research; and (5) the ability to describe and to evaluate major issues and current trends in instructional curriculum practice and development.

Certification programs are also available in the areas of reading specialist (K-12) and private nursery school teachers. For graduates of education undergraduate programs, a total of 36 credits of work normally will be required. Graduates of undergraduate programs other than education normally will be expected to complete substantially more work to satisfy the requirements for this degree. Some of this additional work may include undergraduate courses. Program requirements include 3 credits in foundations of education; each student will be expected to complete from one-third to two-thirds of the work in courses other than education courses; and a minimum of 12 credits in 500-level courses must be completed. The last 12 credits in a student's program must be earned at the Capitol Campus. The application and transcript should be sent directly to the Graduate Office, The Capitol Campus, Middletown, PA 17057.

## EDUCATION (ED)

505. CURRICULUM FOUNDATIONS (3) Study of the philosophical, cultural, social, and human developmental sources and implications of the school curriculum.

506. CURRICULUM DEVELOPMENT (3) Examination of theory, issues, organization, and local school problems of curriculum development.

520. SEMINAR IN JUNIOR COLLEGE TEACHING (3) The history of the two-year college, responsibilities of the teacher in the college organization, and methods of teaching.

541. THE ROLE OF THE COOPERATING TEACHER (3) A study of the responsibilities of classroom teachers who cooperate with teacher-preparation institutions. Prerequisite: teaching experience.

550. INTERNSHIP IN JUNIOR COLLEGE (3) Teaching humanities courses in a two-year college under a master teacher, who will direct, criticize, and evaluate the intern.

551. PROBLEMS IN TEACHING READING (3) A research-centered course in teaching reading. Prerequisite: Ed. 322, 451, 471, or 472.

552. PROBLEMS IN TEACHING LANGUAGE ARTS (3) A research-centered course in teaching language arts. Prerequisite: Ed. 416 or 452.

553. **PROBLEMS IN TEACHING SOCIAL STUDIES (3)** A research-centered course in teaching social studies. Prerequisite: Ed. 415 or 453.
554. **PROBLEMS IN TEACHING SCIENCE (3)** A research-centered course in teaching elementary science. Prerequisite: Sc. 454.
555. **PROBLEMS IN TEACHING MATHEMATICS (3)** A research-centered course in teaching mathematics. Prerequisite: Ed. 455.
556. **RESEARCH IN CHILD DEVELOPMENT (3)** Focus on contemporary research in the following areas: physical, social, cognitive, language, and perceptual development. Prerequisites: Ed. 401, 586.
560. **CLASSROOM MANAGEMENT (3)** Analysis of teaching styles, classroom behavior and interaction, organization and correlation of classroom activities and subject areas. (Requires practical application in an actual teaching situation.)
561. **PSYCHOLOGY OF READING (3)** Examination of the theoretical bases for reading which have direct practical implication for teaching reading. Prerequisites: Ed. 314, 451.
562. **LEARNING PROBLEMS IN A SCHOOL SETTING (3)** Investigation of surface behaviors and sources of stress in schools which hinder learning, and procedures for overcoming problems.
563. **ADVANCED METHODS IN TEACHING READING (3)** Advanced development of diagnostic and instructional techniques for teaching reading, with emphasis on individual and small group instruction. Prerequisite: Ed. 451.
564. **READING CLINIC (3-6)** A practicum course in which students display their competencies in working with children possessing reading problems. Prerequisites: Ed. 421, 422, 423, 561, 562, 563, Ps.Sc. 405, 406.
571. **GREAT TEACHERS (3)** Study of one or more great teachers, e.g., Socrates, Comenius, Locke, Rousseau, Pestalozzi, Herbart, Froebel, Dewey, Kilpatrick.
572. **COMPARATIVE EDUCATION: WORLD PERSPECTIVES (3)** An evaluative comparison of American education with Western and non-Western educational systems.
585. **MASTER'S PRACTICUM (1-6)** The planning, implementation, and evaluation of an educational innovation in a classroom, or related learning activity.
586. **EDUCATIONAL RESEARCH DESIGNS (3)** Identification of research designs appropriate to educational field and laboratory investigations and the development of a master's paper proposal. Prerequisite: 15 credits of graduate study.
587. **MASTER'S PAPER (1-6)** Development of an original master's paper or creative production by the student, supervised by appropriate faculty and judged by a committee. Prerequisite: consent of adviser.
589. **PROBLEMS IN URBAN EDUCATION (4)** Independent study of selected topics related to urban education.
590. **COLLOQUIUM (1-3)**
591. **EDUCATION SEMINAR (1-6)** Seminars in important, and often controversial, topics in education.
596. **INDIVIDUAL STUDIES (1-6)**
597. **SPECIAL TOPICS (1-6)**



## THEATRE ARTS (THEA)

ROGER N. CORNISH, *In Charge of Graduate Programs in Theatre Arts*  
103 Arts Building  
814-865-7586

*Degrees Conferred:* M.A., M.F.A.

*Graduate Faculty:* Senior Members Allison, L. Manfull, and Walters.

*Graduate Faculty:* Associate Members Cook, Cornish, Crocken, Duque, Fenwick, Firmin, Gibson, Maddox, H. Manfull, and A. Smith.

This program emphasizes the study of the theatre with the following major objectives: (1) to help each graduate student attain skills and proficiencies in theatre arts; (2) to provide the training, discipline, and opportunities essential to the development of a professional ability in at least one area of the arts of the theatre; (3) to prepare students for active careers in academic, professional, and/or community theatre in a recognizably competitive job market; and (4) to assist students in acquiring discriminating taste and critical judgment in theatre and film.

The Master of Arts degree program provides advanced training in the broad field of the theatre arts. It is designed to prepare the candidate for (1) professional employment as a theatre arts teacher on the secondary or junior college level; (2) critical study and research particularly in preparation for the pursuit of a related doctorate or professional degree; and (3) related professional work in industry, business, or the arts. Two areas of study are required: general theatre (history, theory, criticism, dramatic literature, and research) and practical theatre (acting, directing, design, and technical theatre). A limited number of students pursuing the M.A. in theatre arts may concentrate in film.

Requirements for admission to the M.A. program are:

1. A broad undergraduate preparation in theatre, including 3 credits each in acting, directing, stagecraft, and theatre history; and 6 credits of dramatic literature.
2. An undergraduate grade-point average of no less than 2.50 on a 4.00 scale.
3. Twelve credits in related subject areas such as film, oral interpretation, art, and music.
4. A vita and at least three letters of recommendation should be submitted.

The M.F.A. program is planned to provide a professional emphasis. Specialization in one of the following areas is stressed: acting; directing; management; production (scene design, costuming, lighting or technical direction); or playwriting. A required final project in the area of specialization includes a monograph. The programs require six to nine terms to complete.

Requirements for admission to the M.F.A. program are:

1. Twenty-four credits in theatre arts, including one course each in acting, directing, and theatre crafts. Related courses in the student's area of specialization may be accepted.
2. All students are to submit evidence of ability in their areas of specialization under arrangements to be made with the department. Auditions, prompt books, portfolios, manuscripts, and other appropriate presentations are to be submitted by applicants to the various study programs.
3. A vita and letters of recommendation (at least three) are to be submitted.
4. Personal interviews should be arranged by all students.

All students in the M.A. and M.F.A. programs who are deficient in the required undergraduate courses may be requested to take additional course work in the areas of deficiency without degree credit.

Under certain circumstances the Ph.D. degree is offered by the Department of English with specialization in drama and minor work in theatre arts.

All graduate majors are required to participate in University Theatre productions in positions of responsibility.

Theatre facilities are the Playhouse, a proscenium-thrust theatre; the Pavilion, an arena or three-quarter theatre; theatre production studios for scenic, property, and costume preparation; rehearsal and

dance studios; feature and documentary film collection; and a film laboratory with production, editing, and screening facilities. Other University performance facilities include Schwab Auditorium, Kern Assembly Room, Music Concert Hall, and the Milton S. Eisenhower Auditorium with a seating capacity of 2,600. On the campus are several FM radio stations and WPSX, the University's educational TV station.

Related courses offered by other departments may be taken. Dramatic literature courses are available: Class. 411; C.Lit. 486, 487, 588; Engl. 438, 444, 445, 478, 488, 548, 549; Fr. 461, 518, 534, 535; Greek 421, 422. Design and technical courses are available in the Departments of Art, Art History, Engineering, Art Education, Architecture, Human Development, and Vocational Industrial Education. Courses in performance areas are available in the Departments of Music, Music Education, Physical Education, and Speech Communication.

### THEATRE ARTS (THEA)

- 400. ADVANCED THEATRE AND FILM PROJECTS (1-6)
- 401. HISTORY OF ANCIENT AND MEDIEVAL THEATRE (3)
- 402. HISTORY OF RENAISSANCE AND ORIENTAL THEATRE (3)
- 403. HISTORY OF MODERN EUROPEAN AND BRITISH THEATRE (3)
- 405. HISTORY OF AMERICAN THEATRE (3)
- 409. FUNDAMENTALS OF CREATIVE PERFORMANCE FOR CLASSROOM TEACHERS (3)
- 410. CREATIVE DRAMATICS WITH CHILDREN (3)
- 411. PROJECTS IN CREATIVE DRAMATICS (2)
- 415. CHILDREN'S THEATRE ENSEMBLE (3 per term, maximum of 9)
- 416. STAGING THEATRE WITH CHILDREN (3)
- 417. EXPERIMENTAL TECHNIQUES IN CHILDREN'S THEATRE (3)
- 418. PUPPETRY (3)
- 420. ADVANCED VOICE AND DICTION FOR THE ACTOR (3 per term, maximum of 6)
- 421. DIALECTS FOR THE ACTOR (3 per term, maximum of 6)
- 422. PERFORMANCE FOR THE CAMERA (3)
- 423. TECHNIQUES AND STYLES OF THEATRE JAZZ DANCE (3 per term, maximum of 6)
- 424. DANCE FOR THE THEATRE (3)
- 425. DANCE FOR THE CONTEMPORARY MUSICAL THEATRE (2-6)
- 426. CHOREOGRAPHY FOR THE THEATRE (3 per term, maximum of 9)
- 427. THEATRE MAKEUP (2)
- 428. ADVANCED ACTING PROJECTS (1-9 per term, maximum of 9)
- 429. THEATRE PERFORMANCE PRACTICUM (1-6)
- 434. DIRECTING (3)
- 435. REHEARSAL METHODS FOR THE DIRECTOR (3)
- 436. CENTRAL STAGING (3)
- 437. DIRECTING FOR FILM AND TELEVISION (3)
- 445. ADVANCED PLAYWRITING (3-6)
- 446. ADVANCED SCREENWRITING (3-6)
- 450. ADVANCED SCENE DESIGN (3-6)
- 460. COSTUME DESIGN (3)
- 461. COSTUME CONSTRUCTION (3)
- 462. DRAFTING HISTORICAL COSTUMES FOR THE STAGE (3)
- 474. STAGE LIGHTING (3)
- 479. STAGE AND PRODUCTION MANAGEMENT (3)
- 483. (C.Lit. 483) FILM AND LITERATURE (3)
- 485. SOUND FOR THEATRE PRODUCTION (3)
- 489. THEATRE PRODUCTION PRACTICUM (1-6 per term, maximum of 12)
- 490. ADVANCED FILM PRODUCTION (3 per term, maximum of 6)
- 491. AMERICAN FILMS (3)
- 492. FOREIGN FILM (3)
- 494. DOCUMENTARY IN FILM AND TELEVISION (3)
- 496. INDEPENDENT STUDIES (1-12)



497. SPECIAL TOPICS (1-6)
499. ADVANCED FILM PRODUCTION PRACTICUM (1-12 per term, maximum of 12)
500. THEATRE RESEARCH: SOURCES AND PROCEDURE (3) Source materials and techniques as applied to theatre research; the form and content of theses and monographs.
503. THEATRE CRITICISM AND THEORY (3)
505. THEATRE HISTORY (3) Specific aspects of theatre from ancient times to the present.
522. ACTING I (4) Interpretation of theatrical styles: the tradition of tragedy; voice and movement.
523. ACTING II (4) Interpretation of theatrical styles: the tradition of comedy; voice and movement. Prerequisite: Thea. 522.
524. ACTING III (4) Interpretation of theatrical styles: forms of modern realism; voice and movement. Prerequisite: Thea. 523.
525. ACTING AND DIRECTING THEORY (3) The actor and director as related to cultural environment from the Greek theatre through the post-Stanislvskian theorists.
528. ADVANCED ACTING PROJECTS (3-9) Advanced performance projects for the second- and third-year M.F.A. actor who has completed all other performance courses.
530. PLAY INTERPRETATION FOR THE DIRECTOR (3) Theory and practice in the analysis and implementation of story, style, and form.
531. SPECIAL FORMS IN DIRECTING (3) Applied theory and techniques for various genres and periods of drama. Prerequisite: Thea. 530.
533. PROJECTS IN DIRECTING (1-6 per term)
535. EXPERIMENTAL THEATRE (1-3) Operational research and experimental methods in the preparation, planning, execution, observation, and evaluation of production.
540. PLAYWRITING (3-6) Focus on problems in writing the full-length script through seminar, play reading, and individual session.
543. PROJECTS IN PLAYWRITING (1-9) Preparation of the script for revision during and following production of the student's original play. Prerequisite: production approval.
553. DESIGN AND TECHNICAL PRODUCTION (1-6 per term) Special projects in design and technical execution of scenery, costumes, lighting, sound, and special effects.
560. COSTUME DESIGN (1-6) Design concepts, rendering, and execution of costumes for the stage.
574. LIGHTING FOR THEATRE PRODUCTION (3) Design techniques for production in arena, thrust, and proscenium theatre situations.
580. THEATRE TECHNOLOGY (3) Design consultation and specification of equipment, systems, and movable structures for new theatres; structures and projection devices for production.
582. THEATRE ADMINISTRATION (3) The theatre: organization and management.
583. PROJECTS IN THEATRE ADMINISTRATION, MANAGEMENT, AND OPERATIONS (1-6)
585. THEATRE PLANNING (3) Processes and problems in planning and designing theatres: performance, audience, and technical requirements.
590. COLLOQUIUM (1-3)
591. SPECIAL PROBLEMS IN FILM AND TV (1-3 per term)
596. INDIVIDUAL STUDIES (1-6)
597. SPECIAL TOPICS (1-6)

## URBAN AND REGIONAL PLANNING (UR PL)

IRVING HAND, *Program Chairman*  
The Capitol Campus  
Middletown, PA 17057  
717-948-6173

*Degree Conferred:* M.R.P.

*Graduate Faculty:* Senior Members Ferguson, Hand, and McDermott.

*Graduate Faculty:* Associate Members Buskirk and Simko.

The objective of this interdisciplinary program is to train professional planners who will be aware of the needs of citizens so that they can develop programs for sound social, political, economic, and cultural advancement through the enlightened management of all resources. The nonthesis option is available for this program. Course work may be taken at The Capitol Campus or at the Radnor Graduate Center.

For admission a student should have had at least one course each in economics, geography or geology, graphics, and statistics. Students may be admitted with limited deficiencies but are required to remove the deficiencies early in the program without graduate degree credit. Applicants should submit scores on the Graduate Record Examination with their application. Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered up to the number of spaces available. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

The program is officially recognized by the American Planning Association.

### REGIONAL PLANNING (R PL)

400-401. PRINCIPLES OF REGIONAL PLANNING (3-6)

410. PLANNING PROGRAMS (3)

440. PROBLEMS IN COMMUNITY AND REGIONAL PLANNING (1-9)

500. (P.Adm. 503) RESEARCH METHODS (1-3 per term) Examination of research methodologies relevant to administration, planning, and public policy. Prerequisite: 3 credits in statistics.

501. APPLIED METHODOLOGIES IN REGIONAL PLANNING (3) Selected methodologies used in planning, including demographic projections, simulations, network analyses, threshold analyses, allocation and location models. Prerequisite: R.Pl. 500.

502. REGIONAL SYSTEMS ANALYSIS (3-6) Spatial structure of regional and interregional systems. Theories of regional development. Spatial measures of location, density, central tendency, and dispersion.

510. PLANNING TECHNIQUES AND ANALYSIS I (3) Regional socioeconomic structure, problems, and factors in planning; data collection, analysis, and implications.

520. PLANNING TECHNIQUES AND ANALYSIS II (3) Interaction of man and environment; land and water resources in regional planning; environmental factors as planning parameters.

530. PLANNING TECHNIQUES AND ANALYSIS III (3) Effects of political, cultural, and physical factors on planning.

540. PROBLEMS IN REGIONAL PLANNING (1-9) Planned individual projects involving library, laboratory (studio), or field work.

587. MASTER'S PROJECT (1-6) An original scholarly master's project initiated by the student, supervised by an appropriate professor, and judged by a committee.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)



## VETERINARY SCIENCE (V SC)

C. S. CARD, *Head of the Department*  
115 Animal Industries Building  
814-865-7696

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Card, Eberhart, Gentry, Massaro, Rothenbacher, Scholz, and Zarkower.

*Graduate Faculty:* Associate Members Ferguson, Griel, Harkness, Patton, Swope, and R. A. Wilson.

Graduate programs may be initiated with faculty specializing in areas of veterinary pathology, toxicology, physiology, microbiology, and immunology. A thesis is required of candidates for both the M.S. and Ph.D. degrees.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by one of several options including proficiency in reading a foreign language. Foreign students must show competence in English.

Prerequisite for admission is a bachelor's degree in an area of the life sciences or a degree in veterinary medicine. Adequate preparation in the basic sciences is required. Applicants with a 3.00 or better grade-point average and appropriate course backgrounds will be considered. Application for fall term admission must be completed by March 1 and must include Graduate Record Examination scores for the Aptitude Test and Advanced Biology Test.

### VETERINARY SCIENCE (V SC)

405. LABORATORY ANIMAL SCIENCE (3) *Ferguson*

407. DAIRY HERD HEALTH PROGRAMS (2)

418. METHODS OF ANIMAL CELL CULTURE (3) *Patton*

420. GENERAL ANIMAL PATHOLOGY (3) *Rothenbacher*

496. INDEPENDENT STUDIES (1-12)

525. MECHANISMS OF HYPERSENSITIVITY AND IMMUNOPATHOLOGY (3) Concepts of hypersensitivity and special consideration of immunopathological conditions. Prerequisites: Biol. 437, Micrb. 410, and 3 credits of pathology. *Zarkower and Ferguson*

528. DIAGNOSTIC PATHOLOGY (3-9) Gross examination of animals and birds, their tissues and body fluids for pathologic changes. Prerequisite: 6 credits in pathology, microbiology, or infectious diseases. *Card*

535. ACQUIRED AND CONGENITAL DISORDERS OF METABOLISM (3) Abnormalities and alterations in metabolism due to dysfunctions of animal organs. Prerequisites: 6 credits in general biochemistry and 3 credits in animal physiology. *Scholz*

550. EXPERIMENTAL ANIMAL SURGERY (3) Principles of surgical preparation of experimental animal models for biological research, including aseptic procedures, anesthesia, surgical techniques, and aftercare. Prerequisites: Biol. 42, 421; V.Sc. 405. *Kavanaugh*

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-6)

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## VOCATIONAL EDUCATION (VOCED)

DAVID L. HOWELL, *In Charge of Graduate Programs in Vocational Education*  
106 Armsby Building  
814-863-0443

*Degrees Conferred:* Ph.D., D.Ed.

*Graduate Faculty:* Senior Members Brantner, Curtis, Howell, Koble, Long, Love, Murray, Passmore, Ray, Shear, Shemick, Stinson, Weis, Welch, and Wircenski.

*Graduate Faculty:* Associate Members Evans, Lindley, Mortensen, Morton, Thal, and Yoder.

This intercollege program emphasizes administration, research, teacher education and supervision, and curriculum development and design across program areas in vocational education.

A minimum of 45 credits is required in the major, to be divided among vocational education, general professional education, and social and behavioral science courses. A minor program of study is required for the D.Ed. degree and is optional for the Ph.D. degree, and may be developed within one of five social and behavioral science options, in general studies, or in other areas approved by the candidate's committee.

The communication and foreign language requirement for the Ph.D. degree may be satisfied from nine options, which include foreign languages, computer science, statistics, technical writing, and philosophic thought.

For admission, students must have a master's degree. Either the master's degree or the bachelor's degree must be in a vocational education specialization, or the applicant must have professional experience in vocational education.

Courses appropriate to these degrees taught in the three participating departments are Ag.Ed. 418v, 420v, 422v, 424v, 426v, 434v, 501v, 502v, 508v, 509v, 520v, 521v, 524v, 530, 590v, 596v; I.Ed. 402, 403, 408, 409, 415, 427, 446, 450, 501, 506, 510, 550, 556, 557, 558, 559, 560; H.E.Ed. 406, 477, 478, 481, 482, 503, 504, 510, 511, 518, 521, 577.

## VOCATIONAL EDUCATION (VOCED)

413v. (Spl.Ed. 413) VOCATIONAL EDUCATION FOR SPECIAL-NEEDS LEARNERS (3)

417v. (Cn.Ed. 417) CAREER EDUCATION: ORIGINS, THEORY, IMPLEMENTATION (3)

496v. INDEPENDENT STUDIES (1-12)

497v. SPECIAL TOPICS (1-6)

500v. FOUNDATIONS OF VOCATIONAL EDUCATION (3) Influence of legislative, economic, and social-psychological developments on the status and role of public vocational education in the United States.

508v. ADMINISTRATION OF VOCATIONAL EDUCATION (3) Concepts, strategies in administration of vocational programs in comprehensive high schools, area vocational technical schools, proprietary schools, and colleges.

530v. INTERNSHIP (1-10) Internship at cooperating school, governmental agency, or research institution, under supervision of graduate faculty. Prerequisites: admission to candidacy and completion of 15 credits in residence beyond master's degree.

590v. COLLOQUIUM (1-3)

596v. INDIVIDUAL STUDIES (1-6)

597v. SPECIAL TOPICS (1-6)



## VOCATIONAL INDUSTRIAL EDUCATION (VI ED)

FREDERICK G. WELCH, *In Charge of Graduate Programs in Vocational Industrial Education*  
103 Rackley Building  
814-865-8361

*Degrees Conferred:* Ph.D., D.Ed., M.S., M.Ed.

*Graduate Faculty:* Senior Members Long, Passmore, Welch, and Wircenski.

Emphasis may be placed upon preparation for teaching, supervision, administration, research, or teacher education. The primary focus of the program is preparation for entry into responsible positions within the broadly conceived field of vocational industrial education.

The communication and foreign language requirement for the Ph.D. degree may be met by the successful completion of selected courses in statistics and computer programming.

Persons admitted must have successfully completed a B.S. degree with a 2.50 grade-point average in vocational industrial education or fields related to vocational, safety, or technical education, or health occupations. Two years or more of experience in vocational industrial education, industrial training, military technical training, or work experience in an occupation related to vocational industrial education, vocational education, health occupations, safety education, or technical education are also required for admission. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

## INDUSTRIAL EDUCATION (I ED)

- 402. SUPERVISION OF VOCATIONAL EDUCATION (3)
- 403. SUPERVISED FIELD WORK (6)
- 408. OCCUPATIONS (3)
- 409. TESTS AND MEASUREMENTS (3)
- 415. PROBLEMS IN COORDINATING VOCATIONAL EDUCATION (3)
- 427. ADVANCED COURSE OF STUDY BUILDING (3)
- 446. IMPROVEMENT OF INSTRUCTION IN VOCATIONAL EDUCATION (4)
- 450. SHOP LAYOUT AND MANAGEMENT (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
  
- 501. SEMINAR IN VOCATIONAL EDUCATION (6) Conferences, investigations, and discussion for advanced students and mature persons who have had experience as teachers, supervisors, or administrators.
- 506. ADMINISTRATION OF VOCATIONAL EDUCATION (3) The job of the local director of industrial education in organizing and developing city and other local programs of industrial education. Prerequisite: 6 credits in industrial education, valid director's certificate, or equivalent training and experience.
- 510. VOCATIONAL EDUCATION FOR ADMINISTRATORS (3) Designed for school administrators and supervisors who desire an understanding of practical arts and vocational education. Prerequisite: I.Ed. 1 or trade or teaching experience.
- 550. RESEARCH IN VOCATIONAL EDUCATION (3) Research techniques in vocational industrial education.
- 556. FEDERAL LEGISLATION (2-3) Recent federal legislative activities and executive orders that bear directly and indirectly upon industrial education.
- 557. PRESENT-DAY LOCAL, PERSONNEL, AND CURRICULUM PROBLEMS (2-3) Various plans, techniques, and practices.
- 558. STATE AND LOCAL SUPERVISION AND ADMINISTRATION (2-3) The more important recent problems in organization, supervision, and administration.

559. VOCATIONAL TECHNICAL EDUCATION (2-3) Problems of organization and administration of programs of technical education at the secondary and postsecondary levels. Prerequisite: 6 credits in industrial education, valid director's certificate, or equivalent training and experience.

560. PHILOSOPHY OF INDUSTRIAL EDUCATION (3) Principles and beliefs of progressive industrial education; literature for evaluating instructional practices. Prerequisite: 12 credits in industrial education or teaching experience.

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

### VOCATIONAL INDUSTRIAL EDUCATION (VI ED)

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

## WILDLIFE MANAGEMENT (W L M)

ROBERT S. BOND, *Director of the School of Forest Resources*  
101 Ferguson Building  
814-865-7541

*Degrees Conferred:* M.S., M.Agr.

*Graduate Faculty:* Senior Members Hutnik and Storm.

*Graduate Faculty:* Associate Members Kelly, Rader, Tzilkowski, and Wakeley.

Programs are designed to give students an understanding of the biology and management of wildlife species and their environments, and include training in wildlife ecology, nutrition, physiology, behavior, and pathology of a wildlife species or species groups; study of successional stages, land use, and management of various habitats and their impact on wildlife populations; population dynamics and manipulation of animal numbers; and studies of recreational, aesthetic, and socioeconomic values of wildlife. Most programs of study are strengthened by including appropriate courses offered by related departments. A thesis is required. The Ph.D. degree in forest resources allows specialization in wildlife ecology and management at the doctoral level (see Forest Resources).

The Master of Agriculture is intended to enable students to develop skills as professionals in the communication of technical knowledge. Candidates will elect a minimum of 15 credits of graduate-level courses in communication skills from courses in departments such as Agricultural Education, Instructional Systems, Journalism, Recreation and Parks, Speech Communication, English, and Theatre. Any deficiencies in a student's resource specialties, as judged by his or her advisory committee, must be remedied. An acceptable paper on a selected professional problem or a report of internship training worth 3 credits or more is also required.

For admission, an applicant should have at least a 2.75 grade-point average, a 3.00 junior-senior average, and should have courses that are basic to the individual's field of specialization. Ordinarily these include 12 credits in communication, 12 credits in social sciences and humanities, 12 credits in quantification including calculus and statistics, 9 credits in physical sciences, 9 credits in biological sciences, and 18 credits in forestry, wildlife, or related courses. Graduate Record Examination scores and three reference reports (forms supplied on request) and a brief statement describing the applicant's academic goals, career interests, and special qualifications are required. The best-qualified applicants will be accepted up to the number of spaces available. Exceptions to admission requirements may be made for students with special backgrounds, abilities, and interests.

### WILDLIFE (WIDL)

408. MAMMALOGY (3)

427. RANGE ECOLOGY AND MANAGEMENT (3)

435. WILDLIFE ECOSYSTEMS (3)

446. WILDLIFE ECOLOGY (3)



- 447. WILDLIFE MANAGEMENT (3)
- 492. FIELD RESEARCH TECHNIQUES (3)
- 493. LABORATORY TECHNIQUES IN WILDLIFE RESEARCH (3)
- 495. WILDLIFE INTERNSHIP (1-6)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

547. WILDLIFE MANAGEMENT (3) Management, maintenance, and manipulation of wildlife populations and habitat. Prerequisite: Wildl. 447.

551. WILDLIFE BIOMETRICS AND POPULATION ANALYSIS (3) Application of biometrics and mathematics to concepts and problems in wildlife ecology with emphasis on population analysis. Prerequisites: 3 credits in animal ecology and 6 credits in biometrics or statistics.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2)

## ZOOLOGY (ZOO)

E. S. LINDSTROM, *Head of the Department of Biology*  
208 Erwin W. Mueller Building  
814-865-4562

*Degrees Conferred:* Ph.D., M.S.

*Graduate Faculty:* Senior Members Anthony, Bellis, Cooper, Dunson, Hibbard, Hollis, MacCluer, Pearson, Wickersham, and Williams.

*Graduate Faculty:* Associate Members Arnold, Mitchell, Neff, Petters, and Turpen.

This program offers emphasis in animal behavior, cell biology, developmental biology, ecology, endocrinology, fishery biology, genetics, histology, ichthyology, invertebrate zoology, morphology, physiology, or population dynamics.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of one foreign language.

Admission is restricted to students who have a baccalaureate degree in a biological science with emphasis on zoological subjects and adequate preparation in mathematics and the physical sciences. A cumulative undergraduate average of at least 3.00 is required. Each applicant must provide scores from the Graduate Record Examination, letters from two persons who are familiar with the student's academic competence, and a personal statement of interests and objectives.

NOTE: *For courses in Zoology and related subjects see Biology, Genetics, and Physiology.*

## OTHER GRADUATE COURSES AND OPTIONS

The following courses are interdisciplinary or in fields in which neither graduate major nor minor work is offered at this institution. The courses, however, carry graduate credit and, with the approval of the major department head or program chairman, may be applied toward the requirements for a degree either as elective courses or as a part of a general studies program. The usual restrictions upon the use of 400-series courses in degree programs apply to these courses.

### ADMINISTRATION OF JUSTICE (ADM J)

- 401. PROBATION, PAROLE, AND PARDONS (3)
- 410. CORRECTIONAL COUNSELING PROCESSES (3)
- 420. SPECIAL OFFENDER TYPES (3-6)
- 430. CORRECTIONAL INSTITUTIONS AND SERVICES (3)
- 440. FUNDAMENTAL TECHNIQUES OF SCIENTIFIC CRIMINAL INVESTIGATION (3)
- 441. THE JUVENILE JUSTICE SYSTEM (3)
- 460. HISTORY AND FUNCTION OF CRIMINAL JUSTICE COMPONENTS (3)
- 470. LAW OF CRIMES AND CORRECTIONS (3)
- 471. LEGAL RIGHTS, DUTIES, LIABILITIES OF CRIMINAL JUSTICE PERSONNEL (3)
- 472. CRIME AND THE AMERICAN COURT SYSTEM (3)
- 482. SEMINAR, CRIMINAL JUSTICE AGENCY ADMINISTRATION (3)
- 495. FIELD PROJECT IN ADMINISTRATION OF JUSTICE (8)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

### AGRICULTURE, GENERAL (AG)

- 400. INTRODUCTORY BIOMETRY (3)
- 495. INTERNSHIP (1-10)

### AMERICAN STUDIES (AM ST)

- 402. SEMINAR IN AMERICAN STUDIES (3-9)
- 405. ETHNICITY AND THE AMERICAN EXPERIENCE (3)

501. THEORY AND METHODS OF AMERICAN STUDIES (3) Theory and methods for the analysis of American culture: history of ideas, analysis of myth and symbol, comparative arts, etc.

502. PROBLEMS IN AMERICAN STUDIES (3-6) A variable-content course, addressed each term to a specific problem, topic, or period in American culture.

- 596. INDIVIDUAL STUDIES (1-6)

### ANIMAL SCIENCE (AN SC)

- 422. QUANTITATIVE INHERITANCE AND ANIMAL BREEDING (3)
- 455. ANIMAL GENETICS (2)
- 464. ANIMAL BEHAVIOR — SOCIOBIOLOGY (3)

### APPLIED MATHEMATICS (A M)

- 417. (Math. 417) TENSOR ANALYSIS (3)
- 418. (Math., Stat. 418) DISCRETE PROBABILITY THEORY (3)
- 419. (Math., Phys. 419) THEORETICAL MECHANICS (3)
- 431. (Math. 431) ORDINARY DIFFERENTIAL EQUATIONS (3)
- 432. (Math. 432) FOURIER SERIES AND PARTIAL DIFFERENTIAL EQUATIONS (3)
- 433. (Math. 433) OPERATIONAL MATHEMATICS (3)



441. (Math. 441) **MATRIX ALGEBRA** (3)
451. (Math. 451) **ADVANCED CALCULUS FOR ENGINEERS I: REAL VARIABLES** (3)
452. (Math. 452) **ADVANCED CALCULUS FOR ENGINEERS II: COMPLEX ANALYSIS** (3)
461. (Math., Phys. 461) **THEORETICAL MECHANICS** (3)
496. **INDEPENDENT STUDIES** (1-12)
504. (Math. 504) **OPTIMIZATION THEORY** (3) Least squares problems, min-max game theory, global theory of constrained optimization, iterative methods of optimization. Prerequisite: Math. 420.
505. (Math. 505) **INTEGRAL EQUATIONS** (3) Fredholm and Volterra equations, and applications. Prerequisite: A.M. (Math.) 431 or 432 or Math. 420.
506. (Math. 506) **DISTRIBUTIONS AND GENERALIZED FUNCTIONS** (3) Schwartz-Sobolev theory of distributions, tempered distributions, Fourier transforms, fundamental solutions of ordinary and partial differential equations; applications. Prerequisite: A.M. (Math.) 431 or 432 or Math. 420.
507. (Math. 507) **CALCULUS OF VARIATIONS AND OPTIMAL CONTROL** (3) Classical and modern theory of the calculus of variations; problems in optimal control. Prerequisite: A.M. (Math.) 431 or 432 or Math. 420.
512. (Stat. 512) **INTRODUCTION TO STOCHASTIC PROCESSES** (3) Markov chains, random walk and recurrent events, queuing theory, time-dependent stochastic processes. Prerequisite: Stat. 409 or A.M. (Stat., Math.) 418.
513. (Stat. 513) **INTRODUCTION TO STOCHASTIC PROCESSES** (3) Markov chains, random walk and recurrent events, queuing theory, time-dependent stochastic processes. Prerequisite: A.M. (Stat.) 512.
515. (Math. 515) **PARTIAL DIFFERENTIAL EQUATIONS OF MATHEMATICAL PHYSICS** (3) Methods of solution of selected elliptic, parabolic, and hyperbolic partial differential equations with reference to physical applications. Prerequisite: A.M. (Math.) 431 or 432.
516. (Math. 516) **ADVANCED PARTIAL DIFFERENTIAL EQUATIONS** (3) Elliptic operators, fundamental solutions, weak and strong derivatives, Sobolev inequalities, Dirichlet problem, equations of evolution, semi-groups. Prerequisite: A.M. (Math.) 515.
- 560-561. (Math. 560-561) **ORDINARY DIFFERENTIAL EQUATIONS** (3 each) Linear spaces and operators, existence and uniqueness of solutions, linear systems, Green's functions, eigenvalue problems—including Fourier series. Prerequisite: Math. 250 or 383 or A.M. (Math.) 431.
573. **SPECIAL TOPICS** (2-12) Various topics according to instructor and students. Prerequisite: second-year graduate standing.

## THE ARTS (ARTS)

400. **CONTEMPORARY FORMS IN THE ARTS** (3)
496. **INDEPENDENT STUDIES** (1-12)
602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING** (1-2 per term, maximum of 6)

## BEHAVIORAL SCIENCE (BEHSC)

410. **BIOSTATISTICS** (2)
501. **BEHAVIORAL SCIENCE** (3) Integration of biopsychosocial substrates of behavior variability in behavior, growth, and development; and behavioral correlates of disease and health.
502. **BEHAVIORAL SCIENCE** (2) Continued integration of biopsychosocial substrates with emphasis on adaptation, growth, and development, and behavioral correlates of disease and health.
503. **HEALTH BEHAVIOR AND HUMAN ECOLOGY** (3) Behavioral substrates with emphasis on health behavior, human ecology, stress, behavioral factors in disease, society, prevention, and health systems. Prerequisite: Beh.Sc. 502.

511. MEDICAL STATISTICS AND RESEARCH DESIGN (2) Use of theoretical and applied statistics in medical research design and in the interpretation of data.
531. BEHAVIORAL AND PHYSIOLOGICAL CORRELATES OF STRESS (3) Effects of stress on all physiological processes; role of learning, cognition, personality, and culture in adapting to stress.
533. BIOFEEDBACK AND THE CONTROL OF INTERNAL RESPONSES (2) Discusses theoretical and clinical applications of voluntary control over EEG, cardiovascular and muscle activity, body temperature, and other physiological processes.
535. NERVOUS SYSTEMS AND BEHAVIOR (3) Synthesis of behavioral science, neurobiology, and physiology with emphasis on integrative functions of peripheral, central, and autonomic nervous systems.
537. MECHANISMS OF MEMORY (2) Discussion of physiological mechanisms involved in information storage and retrieval. Experimental design in memory research is emphasized.
551. HEALTH, ILLNESS, AND CULTURE (3) A medical sociology seminar devoted to the socio-cultural aspects of health and sickness.
555. BEHAVIOR CHANGE (3) Review of behavioral science research and theory relevant for behavior change procedures used in medicine.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-6)
597. SPECIAL TOPICS (1-6)

#### **BIOLOGICAL HEALTH (B H)**

401. BEHAVIORAL CONCEPTS AND HEALTH INTERVENTION (3)
496. INDEPENDENT STUDIES (1-12)
497. SPECIAL TOPICS (1-6)

#### **BLACK STUDIES**

Students who wish to take courses in black studies may select from the following: Anthy. 424, 447; Com.D. 407, 419; C.Lit. 422, 423; Ed.Th.P. 411; Econ. 424; Fr. 458; Geog. 444; Hist. 459, 477, 478; Pl.Sc. 453, 454; Soc. 415, 419.

#### **CHINESE (CHNS)**

496. INDEPENDENT STUDIES (1-12)
497. SPECIAL TOPICS (1-6)

#### **COMMUNITY DEVELOPMENT (COM D)**

402. POLITICS, POLICY, AND COMMUNITY ACTION (3)
404. COMMUNITY DEVELOPMENT THROUGH PLANNED CHANGE (3)
405. COMMUNITY MENTAL HEALTH: AN ECOLOGICAL APPROACH TO HUMAN SERVICES (3)
407. COMMUNITY CONFLICT THEORY (3)
417. IDENTIFYING COMMUNITY POWER STRUCTURES (3)
419. COMPARATIVE COMMUNITY DEVELOPMENT (3)
421. AGING AND SOCIAL POLICY (3)
433. PLANNING OF COMMUNITY SERVICE PROGRAMS (3)
434. EVALUATION OF COMMUNITY SERVICE PROGRAMS (3)
435. COST-EFFECTIVENESS ASSESSMENT OF COMMUNITY SERVICE PROGRAMS (3)
450. COMMUNITY SERVICES STUDIO (1-6)
- 495a. ADVANCED FIELD WORK (4)
- 495b. SEMINAR — FIELD WORK IN COMMUNITY DEVELOPMENT (2)



- 495c. RESEARCH IN FIELD WORK (4)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

### **EARTH AND MINERAL SCIENCES (EM SC)**

- 420. (S.T.S. 420) ENERGY AND MODERN SOCIETY (3)
- 596. INDIVIDUAL STUDIES (1-6)

### **EAST ASIAN STUDIES (EA ST)**

- 401. EAST ASIAN STUDIES (3-6)

### **ENGINEERING (ENGR)**

- 410. (S.T.S. 410) TECHNOLOGY: ITS CHARACTER, ROLE, AND FUNCTION (3)
- 450. PATENT FUNDAMENTALS (3)
- 500. SPECIAL TOPICS IN ENGINEERING (1-3)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-2 per term, maximum of 6)

### **ENVIRONMENTAL RESOURCE MANAGEMENT (E R M)**

- 400. SENIOR SEMINAR (1)
- 410. POLLUTION OF ENVIRONMENTAL SYSTEMS (3)
- 411. LEGAL ASPECTS OF RESOURCE MANAGEMENT (3)
- 412. RESOURCE SYSTEMS ANALYSIS (3)
- 413. CASE STUDIES IN ECOSYSTEM MANAGEMENT (3)
- 495. INTERNSHIP (1-13)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

### **FOLKLORE (FOLK)**

- 400. THEORY AND TECHNIQUES OF FOLKLORE (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

### **GERONTOLOGY**

In several programs students may select gerontology or adult development and aging as an area of specialization — in the behavioral and social sciences, in the biological sciences, and in certain professional programs. No major or degree in gerontology is offered. Information may be obtained from the Gerontology Center, S-211 Henderson Human Development Building.

### **HEALTH PLANNING AND ADMINISTRATION (H P A)**

- 410. PRINCIPLES OF PUBLIC HEALTH ADMINISTRATION (3)
- 420. ENVIRONMENTAL HEALTH (3-6)
- 430. PRINCIPLES OF HEALTH PLANNING (3)
- 431. HEALTH PLANNING METHODS (3)
- 432. HEALTH SYSTEMS MANAGEMENT (3)
- 433. HEALTH SYSTEMS THEORY (3)
- 440. EPIDEMIOLOGIC BASIS FOR PLANNING (3)
- 445. (Econ. 445) HEALTH ECONOMICS (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

### **HUMAN DEVELOPMENT (H DEV)**

- 401. PROFESSIONAL ISSUES IN HUMAN DEVELOPMENT (1-3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)
- 499. SENIOR THESIS (1-10)

516. METHODS OF RESEARCH IN HUMAN DEVELOPMENT (1-6) Review of problems and techniques of research in human development.

517. MULTIVARIATE STUDY OF CHANGE AND HUMAN DEVELOPMENT (3) Models of development and change derived from empirical research utilizing multivariate research design and procedures. Prerequisites: at least three statistics courses, including correlation and regression analysis.

### **HUMANITIES (HUMAN)**

- 471. HUMANISTIC STUDIES (1-4)
- 490. (C.&S. 490) HUMANITIES FOR TEACHERS (3)

### **DOCTORAL MINOR/OPTION IN THE HUMANITIES**

Doctoral candidates may pursue an individualized program of study leading to a certificate minor or option (15-18 credits) in a broadly interdisciplinary area in the humanities. This program will normally provide teaching experience in an area of the humanities, and certification will be granted by the College of the Liberal Arts.

### **INTERDISCIPLINARY PROGRAM IN THE HUMANITIES**

Qualified students who wish to receive a Ph.D. degree in one of the graduate major programs in the College of the Liberal Arts or the College of Arts and Architecture, and yet would like to receive an interdisciplinary education, may enter the interdisciplinary program in the humanities after they have been properly enrolled in one of the major programs, provided their interdisciplinary interest lies within the realm of the humanities.

### **INTERNATIONAL UNDERSTANDING (INT U)**

- 400. WORLD AFFAIRS AND INTERNATIONAL UNDERSTANDING (3-6)

### **ITALIAN (IT)**

- 415. DANTE (3)
- 420. PETRARCA AND BOCCACCIO (3)
- 425. THE LITERATURE OF THE ITALIAN RENAISSANCE (3)
- 450. NINETEENTH-CENTURY ITALIAN LITERATURE (3)
- 460. TWENTIETH-CENTURY ITALIAN LITERATURE (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

588. SEMINAR IN ITALIAN LITERATURE (3-12) Common and individual research in special problems.

### **JAPANESE (JAPNS)**

- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)



**LABOR STUDIES (L S)**

- 400. COMPARATIVE INDUSTRIAL RELATIONS SYSTEMS (3)
  - 404. COLLECTIVE BARGAINING TRENDS (3)
  - 411. TRADE UNION ADMINISTRATION (3)
  - 413. COMPARATIVE LABOR MOVEMENTS (3)
  - 414. THEORIES OF THE LABOR MOVEMENT (3)
  - 433. THE LAW OF LABOR-MANAGEMENT RELATIONS (3)
  - 435. LABOR RELATIONS IN THE PUBLIC SECTOR (3)
  - 437. IMPASSE RESOLUTION IN LABOR RELATIONS (3)
  - 454. (Soc. 454) INDUSTRY AND THE COMMUNITY (3)
  - 455. (Soc. 455) THE SOCIOLOGY OF WORK (3)
  - 458. (Hist. 458) HISTORY OF AMERICAN ORGANIZED LABOR SINCE 1877 (3)
  - 495. LABOR STUDIES INTERNSHIP (1-9)
  - 496. INDEPENDENT STUDIES (1-12)
  - 497. SPECIAL TOPICS (1-6)
- 
- 596. INDIVIDUAL STUDIES (1-6)
  - 597. SPECIAL TOPICS (1-6)

**LANDSCAPE ARCHITECTURE (LARCH)**

- 431. LANDSCAPE DESIGN — AREA ANALYSIS (3)
  - 432. LANDSCAPE DESIGN — SITE ANALYSIS (3)
  - 433. LANDSCAPE DESIGN — DETAIL ANALYSIS (3)
  - 434. PARK FACILITY PLANNING AND EVALUATION (3)
  - 435. LANDSCAPE CONSTRUCTION MATERIALS (3)
  - 437. BASIC LANDSCAPE CONSTRUCTION (3)
  - 439. ADVANCED LANDSCAPE CONSTRUCTION (3)
  - 441. LANDSCAPE DESIGN — DETAIL DESIGN (3)
  - 442. LANDSCAPE DESIGN — AREA DESIGN (3)
  - 443. LANDSCAPE DESIGN — SITE DESIGN (3)
  - 444. LANDSCAPE ARCHITECTURE FIELD TRIP (1)
  - 451. COMPREHENSIVE LANDSCAPE DESIGN I (4)
  - 452. COMPREHENSIVE LANDSCAPE DESIGN II (4)
  - 453. COMPREHENSIVE LANDSCAPE DESIGN III (4)
  - 457. PROFESSIONAL PRACTICE (2)
  - 458. ADVANCED LANDSCAPE COMMUNICATIONS (2)
  - 471. PARK PLANNING THEORY AND CONCEPTS (2)
  - 472. PLANNING AND PUBLIC POLICY (3)
  - 473. RECREATION RESOURCE PLANNING (3)
  - 474. SITE ENGINEERING FUNDAMENTALS (1)
  - 475. PARK SYSTEMS PRACTICUM (1)
  - 491. LANDSCAPE SEMINAR I (1)
  - 492. LANDSCAPE SEMINAR II (1)
  - 493. LANDSCAPE SEMINAR III (1)
  - 496. INDEPENDENT STUDIES (1-12)
  - 497. SPECIAL TOPICS (1-6)
  - 499. FIELD EXPERIENCE (1-3)
- 
- 518. ADVANCED PROBLEMS IN LANDSCAPE DESIGN (2-12) Selected problems for original investigation in the design, construction, and maintenance of landscape architectural projects.
  - 521. TECHNICAL LANDSCAPE ARCHITECTURAL PRACTICES (2-12) Specific technical and professional problems in landscape architectural planning and practice.

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

### LIBERAL ARTS (L A)

400. CHANGING LIFE STYLES (1)

460. UNDERGRADUATE INTERNSHIP (1-6)

461. ACADEMIC ADVISER TRAINING (1)

480. (S.T.S. 480) TECHNOLOGICAL CHANGE AND HUMAN VALUES (3)

481. (Sp.Com. 481) COMPUTER APPLICATIONS TO COMMUNICATION STUDIES (3)

482. QUANTITATIVE METHODS FOR HUMANISTS I (3)

483. QUANTITATIVE METHODS FOR HUMANISTS II (3)

484. (Engl. 484) COMPUTATIONAL AND QUANTITATIVE STYLISTICS (3)

495. UNDERGRADUATE FIELD EXPERIENCE OR PRACTICUM (1-12)

496. INDEPENDENT STUDIES (1-12)

497. SPECIAL TOPICS (1-6)

582. APPROACHES TO PROBLEM SOLVING FOR HUMANISTS (3) A consideration of systematic individual and group approaches to problem solving and evaluation techniques. Prerequisite: introductory statistics.

596. INDIVIDUAL STUDIES (1-6)

### LIBRARY STUDIES (L ST)

470. FEDERAL AND LEGAL INFORMATION RESOURCES (3)

480. BIBLIOGRAPHIC RESOURCES AND SYSTEMS (3)

490. (Hist. 490) ARCHIVAL MANAGEMENT (1-3)

496. INDEPENDENT STUDIES (1-12)

497. SPECIAL TOPICS (1-6)

### LITHUANIAN (LITH)

500. STRUCTURE OF LITHUANIAN (3) Analysis of the phonology, morphology, and syntax of Lithuanian; comparative linguistic study of Balto-Slavic and Indo-European. Prerequisite: one graduate course in linguistics.

### MATERIALS SCIENCE (MATSC)

401. MATERIALS SCIENCE FOR TEACHERS I (3)

404. PROCESS MEASUREMENT AND CONTROL (1-3)

406. INTRODUCTION TO BIOMEDICAL MATERIALS (3)

408. (Geosc. 408) X-RAY DIFFRACTION (3)

411. (Geosc. 411) INSTRUMENTAL TECHNIQUES APPLIED TO MATERIALS AND MINERAL SCIENCE PROBLEMS (1-8)

*Unit A. X-RAY DIFFRACTION*

*Unit B. TRANSMISSION ELECTRON MICROSCOPY*

*Unit C. SPECTROSCOPY*

*Unit D. ELECTRON MICROPROBE ANALYSIS*

*Unit E. SCANNING ELECTRON MICROSCOPY*

*Unit F. ABSORPTION SPECTROSCOPY*

*Unit G. ION BEAM TECHNIQUES*

*Unit I. ELECTRON SPECTROSCOPY FOR CHEMICAL ANALYSIS AND AUGER ELECTRON SPECTROSCOPY*

412. QUANTITATIVE MICROSTRUCTURAL AND PARTICULATE CHARACTERIZATION (1)

416. MATERIALS PREPARATION (2)

420. MATHEMATICAL MODELING FOR MATERIALS SCIENTISTS (3)

490. SPECIAL TOPICS IN MATERIALS SCIENCE (1-9)



496. INDEPENDENT STUDIES (1-12)

497. SPECIAL TOPICS (1-6)

501. THERMODYNAMICS OF MATERIALS (3) Application of thermodynamics to materials equilibria and processes, including solution theory, electrochemical processes, capillarity, and the effect of stresses. Prerequisite: Chem. 451.

503. (G.M. 503) KINETICS OF MATERIALS PROCESSES (3) Introduction to application of transition state theory and mass transfer to the kinetics of materials and mineral processes. Prerequisites: Math. 100; Chem. 451; Mat.Sc. 501 or G.M. 521.

512. (G.M. 512) PRINCIPLES OF CRYSTAL CHEMISTRY (2-4) Relation of structure to ionic size and nature; influence of pressure and temperature on structure; chemical-structural defects, crystalline solutions, phase-transitions.

514. CHARACTERIZATION OF MATERIALS (3) Classical and new (microprobe, scanning microscope, magnetic resonance, and Mossbauer) techniques for the characterization of composition, structure, defects, and surfaces.

524. (G.M. 524) VIBRATIONAL SPECTRA OF MATERIALS AND MINERALS (2) Infrared and Raman spectroscopy of solid materials with applications to crystal chemistry, materials characterization, and glass research. Prerequisites: Phys. 412, 471.

531. (G.M. 531) TRANSMISSION ELECTRON MICROSCOPY (2) Discussion of electron image contrast theory as a tool for study of atomic substructures in the materials and mineral sciences. Prerequisite: Mat.Sc. (Geosc.) 411B.

532. (G.M. 532) STRUCTURE ANALYSIS (2) Crystal structure determination methods; space groups, structure factors, heavy atoms and isomorphous replacement, Fourier synthesis, Patterson maps, inequalities, refinement techniques. Prerequisite: Mat.Sc. (Geosc.) 408.

533. (G.M. 533) SINGLE CRYSTAL METHODS (2) Experimental techniques in crystal structure determination: crystal selection, space group determination, measurement of intensities, analysis of data. Prerequisite: Mat.Sc. (Geosc.) 408.

534. (G.M. 534) DIFFRACTION BY CRYSTALS (2) Interaction of radiation with matter: coherent and incoherent scattering, extinction, fluorescence, polarization. Prerequisite: Mat.Sc. (Geosc.) 408.

535. (G.M. 535) GEOMETRICAL CRYSTALLOGRAPHY (3) Derivation of lattices, types, point groups, and space groups, with applications.

538. (G.M. 538) ELECTRON BEAM ANALYSIS OF SOLIDS VIA X-RAY AND ELECTRON EMISSION (3) Theory of phenomena occurring in electron-bombarded solids and their applications to analysis of solids.

540. CRYSTAL ANISOTROPY (3) Symmetry aspects of crystals and physical properties. Matrix and tensor methods. Prerequisite: Phys. 412.

542. MAGNETIC METHODS IN MATERIALS SCIENCE (3) Static magnetic (susceptibility type) and spectroscopic methods (nuclear and electron magnetic resonance, Mossbauer spectroscopy) for materials characterization and structural analysis. Prerequisite: Phys. 413.

552. THEORY AND PRACTICE OF CRYSTAL GROWTH (3) Theoretical approaches to crystal growth and of the various techniques used in growing crystals.

554. ELECTRONIC SPECTRA OF MATERIALS (3) Crystallographic and thermodynamic applications of crystal field theory. Electronic spectra of crystals and glasses. Luminescent spectra and phosphor characterization. Prerequisite: Phys. 471.

570. CATALYTIC MATERIALS (3) Preparation and characterization of solid catalytic materials. Relationships between their surface, defect, and electronic properties and catalytic activity. Prerequisite: Chem. 452.

596. INDIVIDUAL STUDIES (1-6)

597. SPECIAL TOPICS (1-6)

### **MINERAL ENGINEERING (MIN E)**

- 414. PLANNING AND CONTROL FOR THE MINERAL INDUSTRIES (3)
- 415. MANAGEMENT IN THE MINERAL INDUSTRIES FOR ENVIRONMENTAL, LEGAL, AND HEALTH AND SAFETY PROBLEMS (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

### **PATHOLOGY (PATH)**

- 501. PRINCIPLES OF PATHOLOGY (4) The fundamentals of reaction to injury at cellular and tissue levels emphasizing the pathogenesis of functional, structural, and biochemical abnormalities.
- 520. BIOLOGY OF NEOPLASIA (3) Detailed examination of the initiation and pathogenesis of animal neoplasms with emphasis on the relationship to human neoplasia. Prerequisite: admission to College of Medicine.
- 522. CANCER IMMUNOLOGY AND IMMUNOTHERAPY (2) Detailed study of recent advances in host response to malignancy in man and experimental animals. Prerequisite: Path. 501 or Micrb. 554.
- 597. SPECIAL TOPICS (1-6)

### **PEDIATRICS (PED)**

- 525. CLINICAL GENETICS (5-10) Mendelian and molecular principles of human genetics; genetic bases of human disease, quantitative human genetics, prenatal diagnosis, genetic counseling.
- 526. HUMAN CYTOGENETICS (2) Human chromosome identification; structure, replication, and evolution of human and other eukaryotic chromosomes in cytogenetic and molecular terms.

### **PLANT SCIENCE (PLTSC)**

- 400. PRINCIPLES OF PLANT SCIENCE RESEARCH (2)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

### **POPULATION ISSUES**

Qualified students may select population issues studies as an option of specialization when majoring in economics, geography, sociology, anthropology, rural sociology, or agricultural economics. Additional information is given under the description of those majors in the preceding section.

### **PORTUGUESE (PORT)**

- 456. BRAZILIAN LITERATURE IN ENGLISH TRANSLATION (3)
- 496. INDEPENDENT STUDIES (1-12)
- 497. SPECIAL TOPICS (1-6)

- 588. SEMINAR IN PORTUGUESE AND BRAZILIAN LITERATURE (3-12) Common and individual research in special problems.

### **PROFESSIONAL SKILLS MINOR/OPTION**

This minor/option seeks to broaden the analytic, informational, and communications skills that are required of all Ph.D. programs. Doctoral candidates in any disciplinary major at the University may enroll. The program requires the completion of the following course work.

Total credits required: 15



- L.A. 582. APPROACHES TO PROBLEM SOLVING FOR HUMANISTS (3)
- L.A. 596. INDEPENDENT STUDIES (3)
- L.ST. 480. BIBLIOGRAPHIC RESOURCES AND SYSTEMS (3)
- ENGL. 418. ADVANCED TECHNICAL WRITING AND EDITING (3)
- or ENGL. 417. THE EDITORIAL PROCESS (3)
- SP.COM. 552. ORAL COMMUNICATIONS IN INDUSTRY, BUSINESS, AND GOVERNMENT (3)

## **SCIENCE (SC)**

- 400. CONSEQUENCES OF SCIENCE (1)

## **SCIENCE, TECHNOLOGY, AND SOCIETY (S T S)**

- 410. (Engr. 410) TECHNOLOGY: ITS CHARACTER, ROLE, AND FUNCTION (3)
- 420. (E.M.Sc. 420) ENERGY AND MODERN SOCIETY (3)
- 430. FOOD AND MAN: TECHNOLOGY AND FEEDING THE WORLD POPULATION (3)
- 432. (Phil. 432) MEDICAL ETHICS (3)
- 435. (Phil. 435) THE INTERRELATION OF SCIENCE, PHILOSOPHY, AND RELIGION (3)
- 460. SCIENCE AND PUBLIC POLICY (3)
- 470. TECHNOLOGY ASSESSMENT AND INDICATORS OF THE QUALITY OF LIFE (3)
- 471. RADIATION, REACTORS, AND SOCIETY (3)
- 480. (L.A. 480) TECHNOLOGICAL CHANGE AND HUMAN VALUES (3)
- 496. INDEPENDENT STUDIES (1-12)

NOTE: This program is designed to examine critically the impact of scientific investigation and technological development on society and the influence of human needs on scientific investigation and technological development.

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- 407. CORRELATES OF POVERTY (3)
- 411. SOCIAL WORK METHODS: ORGANIZATIONS AND COMMUNITIES (3)
- 415. PREPLACEMENT SEMINAR (1)
- 442. SOCIAL WORK PRACTICE ANALYSIS (2-4)
- 450. PUBLIC WELFARE POLICY AND SERVICES (3)
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# DIRECTORY OF GRADUATE PROGRAMS AND DEGREES CONFERRED

The following degrees are the ones normally conferred in each of the designated major programs. Additional professional degrees, including the M.Agr., M.Ed., and M.Eng., have been authorized in many cases and may be offered at the discretion of the department head or program chairman and the dean of the Graduate School. Page references below are to the pages in the 1983-1984 Graduate Bulletin where the individual program, including faculty, specific admission and degree requirements, and course offerings, is described.

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- Pharmacology (Hershey) — Ph.D., M.S. 290
- Philosophy — Ph.D., M.A. 292
- Physical Education — Ph.D., D.Ed., M.S., M.Ed. 295
- Physics — Ph.D., D.Ed., M.S., M.Ed. 298
- \*Physiology (U.P., Hershey) — Ph.D., M.S. 302**
- Plant Pathology — Ph.D., M.S., M.Agr. 305
- Political Science — Ph.D., M.A. 307
- Polymer Science — Ph.D., M.S. 311
- Poultry Science — M.S. 313
- Psychology — Ph.D., M.S. 314
- Psychosocial Science (Capitol) — M.Ps.Sc. 319
- Public Administration — M.P.A. 322
- Public Administration (Capitol) — M.P.A. 324
- Recreation and Parks — Ph.D., M.S., M.Ed. 327
- \*Regional Planning — M.R.P. 329**
- Rural Sociology — Ph.D., M.S., M.Agr. 330
- School Psychology — D.Ed., M.S., M.Ed. 332
- Sociology — Ph.D., M.A. 334
- \*Solid State Science — Ph.D., M.S. 338**
- Spanish — Ph.D., M.A., M.Ed. 340
- Special Education — Ph.D., M.S., M.Ed. 342
- Speech Communication — Ph.D., M.A. 345
- Statistics — Ph.D., M.S., M.A. 348
- Teaching and Curriculum (Capitol) — M.Ed. 352
- Theatre Arts — M.A., M.F.A. 354
- Urban and Regional Planning (Capitol) — M.R.P. 358
- Veterinary Science — Ph.D., M.S. 360
- \*Vocational Education — Ph.D., D.Ed. 362**
- Vocational Industrial Education — Ph.D., D.Ed., M.S., M.Ed. 364
- Wildlife Management — M.S. 365

\*Intercollege Graduate Program

\*\*See Geosciences

†Dual-title Program Option

## THE GRADUATE COUNCIL 1982-1983

SHELTON ALEXANDER, *Professor of Geophysics\**  
 ROY W. ALLISON, *Associate Professor of Education\**  
 ROBERT B. BEELMAN, *Professor of Food Science\**  
 ERNEST L. BERGMAN, *Professor of Plant Nutrition\*\**  
 DAVID BRAUN, *Graduate Student, Graduate Program in Agricultural Engineering\*\**  
 ROBERT S. BRUBAKER, *Professor of Speech Communication\**  
 ROBERT BURGESS, *Professor of Human Development\**  
 PHILIP D. CADY, *Professor of Civil Engineering\*\**  
 ROBERT CHRISTINA, *Professor of Physical Education\**  
 JOHN D. CONNOR, *Professor of Pharmacology\**  
 DONALD D. DAVIS, *Professor of Plant Pathology\**  
 FRANK DEUTSCH, *Professor of Mathematics\**  
 JOHN DUTTON, *Professor of Meteorology\*\**  
 GERALD G. EGGERT, *Professor of American History\*\**  
 GERARD M. FAETH, *Professor of Mechanical Engineering\**  
 STEPHEN J. FONASH, *Professor of Engineering Science\*\**  
 DANIEL FRITTON, *Associate Professor of Soil Physics\*\**  
 ALFRED GALAT, *Graduate Student, Graduate Program in History\*\**  
 GORDON P. GARMIRE, *Professor of Astronomy\**  
 L. PETER GOLD, *Associate Professor of Chemistry\*\**  
 MICHAEL GREEN, *Assistant Professor of Nutrition Science\**  
 MILES HARER, *Graduate Student, Graduate Program in Sociology\*\**  
 GEORGE J. HEITMANN, *Professor of Management Science\*\**  
 CHARLES HILL, *Associate Professor of Biological Chemistry\*\**  
 ROBERT J. LESNIAK, *Associate Professor of Education\*\**  
 ALPHONSE LEURE-DUPREE, *Associate Professor of Anatomy\**  
 GARY L. LILIEN, *Professor of Management Science\**  
 BRUCE LUBICH, *Graduate Student, Graduate Program in Economics\*\**  
 LOWELL L. MANFULL, *Professor of Theatre Arts\*\**  
 JOSEPH W. MICHELS, *Professor of Anthropology\*\**  
 CHARLES T. MORROW, *Associate Professor of Agricultural Engineering\**  
 M. ELOISE MURRAY, *Associate Professor of Home Economics Education\*\**  
 ROBERT E. NEWNHAM, *Professor of Solid State Science\*\**  
 MERRILL E. NOBLE, *Professor of Psychology\**  
 DAVID L. PASSMORE, *Associate Professor of Vocational Education\**  
 MICHELLE PRACKO, *Graduate Student, Graduate Program in Business Administration\*\**  
 ROBERT A. SECOR, *Associate Professor of English and of American Studies\**  
 BARBARA M. SHANNON, *Associate Professor of Nutrition\*\**  
 BRUCE R. SHOBAKEN, *Professor of Art\**  
 ROBERT E. SHUTE, *Assistant Professor of Health Education\*\**  
 JACK STEIN, *Associate Professor of Electrical Engineering\*\**  
 YOSHIMITSU TAKEI, *Associate Professor of Education\**  
 PATRICIA A. WARD, *Professor of French and Comparative Literature\*\**  
 FREDERICK C. WEDLER, *Associate Professor of Biochemistry\*\**  
 THOMAS M. YORK, *Professor of Aerospace Engineering\**  
 JAMES B. BARTOO, *Dean of the Graduate School, Chairman of the Graduate Council†*  
 RICHARD G. CUNNINGHAM, *Vice President for Research and Graduate Studies†*

\* Term of office expires 1984

\*\* Term of office expires 1983

† Ex officio



# THE GRADUATE SCHOOL

## ADMINISTRATIVE OFFICERS

JAMES B. BARTOO, Ph.D. *Dean*  
M. NELSON MCGEARY, Ph.D. *Dean Emeritus*  
ROBERT W. CARRUBBA, Ph.D. *Associate Dean*  
RICHARD L. MCCARL, Ph.D. *Associate Dean*  
HOWARD B. PALMER, Ph.D. *Associate Dean*  
BENJAMIN F. HOWELL, JR., Ph.D., P.E. *Associate Dean Emeritus*  
ERNEST H. LUDWIG, Ph.D. *Associate Dean Emeritus*  
HARRY D. ZOOK, Ph.D. *Associate Dean Emeritus*  
A. WITT HUTCHISON, Ph.D. *Assistant Dean Emeritus*  
ROBERT E. TSCHAN, M.A. *Assistant Dean Emeritus*  
THEODORE L. GROSS, Ph.D. *Provost and Dean (Capitol Campus)*  
JOHN M. LILLEY, Ph.D. *Dean of the Behrend College*  
HELMUT E. WEBER, D.Sc. *Assistant Dean (assigned to the King of Prussia Center for Graduate Studies and Continuing Education)*  
CHARLES E. GALGOCI, Ph.D. *Director of Graduate Admissions*

## ADMINISTRATIVE OFFICES

### Office of the Dean (814-865-2516)

JAMES B. BARTOO, Ph.D. *Dean*  
DONALD BANY, B.A. *Financial Officer*  
VALERIE NISBET, B.A. *Administrative Assistant*

### Admissions (814-865-1795)

CHARLES E. GALGOCI, Ph.D. *Director of Graduate Admissions*  
CLAIRE P. USHER, B.A. *Assistant Director*

### Data Processing (814-865-3425)

DON K. HOGG, M.B.A. *Data Systems Coordinator*

### Fellowships and Awards (814-865-2514)

RICHARD L. MCCARL, Ph.D. *Associate Dean*  
M. JOAN SCHUMACHER, M.S. *Financial Aid Coordinator*

### Graduate Commons (814-865-5436)

J. DAVID GREBOS, M.F.A. *Director of the Graduate Commons*  
JAMES SCALTZ, M.Ed. *Assistant to the Director*

### Graduate Minority Affairs (814-863-1663)

ROOSEVELT GREEN, JR., M.S.W. *Assistant to the Dean*

### Graduate Program Review (814-863-1663)

HOWARD B. PALMER, Ph.D. *Associate Dean*

### Graduate Student Programs (814-865-1834)

ROBERT W. CARRUBBA, Ph.D. *Associate Dean*

### Intercollege Graduate Programs (814-863-1663)

HOWARD B. PALMER, Ph.D. *Associate Dean*

### Theses and Publications (814-865-5448)

MARQUE BAGSHAW, M.Phil. *Assistant to the Dean*  
PAMELA KATKIN, M.A. *Thesis Editor*

# GRADUATE CALENDAR\*

## FALL SEMESTER 1983

### JULY 1983

- 26 Tuesday — Last date for a prospective graduate student to submit completed application materials for admission to the fall semester 1983. An international applicant should submit materials at least three months before the beginning of the semester or session for which he or she is applying.
- 29 Friday — Last date for a graduate student to apply for permission to resume study in the fall semester 1983

### AUGUST

- 22-25 Monday to Thursday — Orientation and registration
- 26 Friday — Classes begin

### SEPTEMBER

- 5 Monday — Labor Day holiday

### OCTOBER

- 10 Monday — Applications for spring semester 1984 tuition grants-in-aid are due in 320 Kern Graduate Building
- 17 Monday — Last date to submit camera-ready thesis manuscript to Graduate School Thesis Office for December degree conferral
- 24 Monday — Last date for final oral doctoral examination for students who wish to deliver thesis to Graduate School Thesis Office for December degree conferral. These students are reminded to pay the thesis fee at the Bursar's Office *and* to activate diploma card in the Registrar's Office.

### NOVEMBER

- 7 Monday — Last date for departments to certify to Graduate School completion of required papers for December degree conferral
- 7 Monday — Last date to deliver thesis to Graduate School Thesis Office for December degree conferral
- 24-25 Thursday, Friday — Thanksgiving holiday

### DECEMBER

- 6 Tuesday — Last date for a prospective graduate student to submit completed application materials for admission to the spring semester 1984. An international applicant should submit materials at least three months before the beginning of the semester or session for which he or she is applying.
- 7 Wednesday — Last date to resubmit *corrected* final copy of thesis to Graduate School Thesis Office for December degree conferral
- 13 Tuesday — Classes end
- 15-17 Thursday to Saturday — Final examinations
- 16 Friday — Last date for a graduate student to apply for permission to resume study in the spring semester 1984
- 16-17;19-22 Friday, Saturday; Monday to Thursday — Final examinations

\*This calendar is subject to change without notice. In preparing the calendar for an academic year, the University makes every effort to avoid conflict with religious holidays. However, such conflicts are sometimes unavoidable. When they occur, efforts are made to make special arrangements for the students affected.

NOTE: Students who plan to take examinations in French, German, and Spanish should apply through the Office of Graduate Programs, 211 Kern Graduate Building. Times and places of tests will be announced when the application is filed.



## SPRING SEMESTER 1984

### DECEMBER 1983

- 6 Tuesday — Last date for a prospective graduate student to submit completed application materials for admission to the spring semester 1984. An international applicant should submit materials at least three months before the beginning of the semester or session for which he or she is applying.
- 16 Friday — Last date for a graduate student to apply for permission to resume study in the spring semester 1984

### JANUARY 1984

- 11-13 Wednesday to Friday — Orientation and registration
- 16 Monday — Classes begin

### FEBRUARY

- 1 Wednesday — Applications by Penn State graduate students for all 1984-85 fellowships and traineeships awarded by the Graduate School are due in 320 Kern Graduate Building
- 6 Monday — Last date for a May graduate to pay thesis fee at Bursar's Office and to activate diploma card in Registrar's Office
- 15 Wednesday — Applications by incoming graduate students for 1984-85 fellowships and traineeships awarded by the Graduate School are due in 320 Kern Graduate Building

### MARCH

- 5-9 Monday to Friday — Spring holiday
- 9 Friday — Applications for summer session and fall semester 1984 tuition grants-in-aid are due in 320 Kern Graduate Building. A few fall awards may be available for applicants who apply as late as June 29.
- 12 Monday — Last date for a May graduate to submit camera-ready thesis manuscript to Graduate School Thesis Office
- 19 Monday — Last date for final oral doctoral examinations for May graduates

### APRIL

- 2 Monday — Last date for departments to certify to Graduate School completion of required papers for May graduates
- 2 Monday — Last date for a May graduate to deliver thesis to Graduate School

### MAY

- 4 Friday — Classes end
- 7-12 Tuesday to Saturday — Final examinations
- 9 Wednesday — Last date for a May graduate to resubmit *corrected* final copy of thesis to Graduate School Thesis Office
- 11 Friday — Last date for a graduate student to apply for permission to resume study in the summer session 1984
- 14 Monday — Last date for a prospective graduate student to submit completed application materials for admission to the summer session 1984. An international applicant should submit materials at least three months before the beginning of the semester or session for which he or she is applying.
- 19 Saturday — Spring commencement

NOTE: Students who plan to take examinations in French, German, and Spanish should apply through the Office of Graduate Programs, 211 Kern Graduate Building. Times and places of tests will be announced when the application is filed.

## SUMMER SESSION 1984

### MAY 1984

- 11 Friday — Last date for a graduate student to apply for permission to resume study in the summer session 1984
- 14 Monday — Last date for a prospective graduate student to submit completed application materials for admission to the summer session 1984. An international applicant should submit materials at least three months before the beginning of the semester or session for which he or she is applying.

### JUNE

- 11-12 Monday, Tuesday — Orientation and registration
- 13 Wednesday — Classes begin
- 20 Wednesday — Last date for an August graduate to pay thesis fee at Bursar's Office and to activate diploma card in the Registrar's Office

### JULY

- 2 Monday — Last date for final oral doctoral examinations for August graduates
- 2 Monday — Last date for an August graduate to submit camera-ready thesis manuscript to Graduate School Thesis Office
- 4 Wednesday — Independence Day holiday
- 16 Monday — Last date for departments to certify to Graduate School completion of required papers for August graduates
- 16 Monday — Last date for an August graduate to deliver thesis to Graduate School Thesis Office
- 24 Tuesday — Last date for a prospective graduate student to submit completed application materials for admission to the fall semester 1984. An international applicant should submit materials at least three months before the beginning of the semester or session for which he or she is applying.
- 27 Friday — Last date for a graduate student to apply for permission to resume study in the fall semester 1984

### AUGUST

- 8 Wednesday — Classes end
- 9-11 Thursday to Saturday — Final examinations
- 10 Friday — Last date for an August graduate to resubmit *corrected* final copy of thesis to Graduate School Thesis Office
- 18 Saturday — Summer commencement

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NOTE: Students who plan to take examinations in French, German, and Spanish should apply through the Office of Graduate Programs, 211 Kern Graduate Building. Times and places of tests will be announced when the application is filed.



## FALL SEMESTER 1984

### JULY 1984

- 24 Tuesday — Last date for a prospective graduate student to submit completed application materials for admission to the fall semester 1984. An international applicant should submit materials at least three months before the beginning of the semester or session for which he or she is applying.
- 27 Friday — Last date for a graduate student to apply for permission to resume study in the fall semester 1984

### AUGUST

- 20-23 Tuesday to Thursday — Orientation and registration
- 24 Friday — Classes begin

### SEPTEMBER

- 3 Monday — Labor Day holiday

### OCTOBER

- 8 Monday — Applications for spring semester 1985 tuition grants-in-aid are due in 320 Kern Graduate Building
- 15 Monday — Last date to submit camera-ready thesis manuscript to Graduate School Thesis Office for December degree conferral
- 22 Monday — Last date for final oral doctoral examination for students who wish to deliver thesis to the Graduate School Thesis Office for December degree conferral. These students are reminded to pay the thesis fee at the Bursar's Office *and* to activate diploma card in the Registrar's Office.

### NOVEMBER

- 5 Monday — Last date for departments to certify to Graduate School completion of required papers for December degree conferral
- 5 Monday — Last date to deliver thesis to Graduate School Thesis Office for December degree conferral
- 22-23 Thursday, Friday — Thanksgiving holiday

### DECEMBER

- 5 Wednesday — Last date for a prospective graduate student to submit completed application materials for admission to the spring semester 1985. An international applicant should submit materials at least three months before the beginning of the semester or session for which he or she is applying.
- 5 Wednesday — Last date to resubmit *corrected* final copy of thesis to Graduate School Thesis Office for December degree conferral
- 11 Tuesday — Classes end
- 14-15;17-20 Thursday, Friday; Monday to Thursday — Final examinations
- 14 Friday — Last date for a graduate student to apply for permission to resume study in the spring semester 1985

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NOTE: Students who plan to take examinations in French, German, and Spanish should apply through the Office of Graduate Programs, 211 Kern Graduate Building. Times and places of tests will be announced when the application is filed.

## SPRING SEMESTER 1985

### DECEMBER 1984

- 5 Wednesday — Last date for a prospective graduate student to submit completed application materials for admission to the spring semester 1985. An international applicant should submit materials at least three months before the beginning of the semester or session for which he or she is applying.
- 14 Friday — Last date for a graduate student to apply for permission to resume study in the spring semester 1985

### JANUARY 1985

- 9-11 Wednesday to Friday — Orientation and registration
- 14 Monday — Classes begin

### FEBRUARY

- 1 Friday — Applications by Penn State graduate students for all 1985-86 fellowships and traineeships awarded by the Graduate School are due in 320 Kern Graduate Building
- 4 Monday — Last date for a May graduate to pay thesis fee at Bursar's Office *and* to activate diploma card in Registrar's Office
- 15 Friday — Applications by incoming graduate students for all 1985-86 fellowships and traineeships awarded by the Graduate School are due in 320 Kern Graduate Building

### MARCH

- 4-8 Monday to Friday — Spring holiday
- 8 Friday — Applications for summer session and fall semester 1985 tuition grants-in-aid are due in 320 Kern Graduate Building. A few fall awards may be available for applicants who apply as late as June 28.
- 11 Monday — Last date for a May graduate to submit camera-ready thesis manuscript to Graduate School Thesis Office
- 18 Monday — Last date for final oral doctoral examinations for May graduates

### APRIL

- 1 Monday — Last date for departments to certify to Graduate School completion of required papers for May graduates
- 1 Monday — Last date for a May graduate to deliver thesis to Graduate School Thesis Office

### MAY

- 3 Friday — Classes end
- 6-11 Monday to Saturday — Final examinations
- 8 Wednesday — Last date for a May graduate to resubmit *corrected* final copy of thesis to Graduate School Thesis Office
- 13 Monday — Last date for a prospective graduate student to submit completed application materials for admission to the summer session 1985. An international applicant should submit materials at least three months before the beginning of the semester or session for which he or she is applying.
- 13 Monday — Last date for a graduate student to apply for permission to resume study in the summer session 1985
- 18 Saturday — Spring commencement

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NOTE: Students who plan to take examinations in French, German, and Spanish should apply through the Office of Graduate Programs, 211 Kern Graduate Building. Times and places of tests will be announced when the application is filed.



## SUMMER SESSION 1985

### MAY 1985

- 13 Monday — Last date for a prospective graduate student to submit completed application materials for admission to the summer session 1985. An international applicant should submit materials at least three months before the beginning of the semester or session for which he or she is applying.
- 13 Monday — Last date for a graduate student to apply for permission to resume study in the summer session 1985

### JUNE

- 10-11 Monday, Tuesday — Orientation and registration
- 12 Wednesday — Classes begin
- 19 Wednesday — Last date for an August graduate to pay thesis fee at Bursar's Office and to activate diploma card in Registrar's Office

### JULY

- 1 Monday — Last date for final oral doctoral examinations for August graduates
- 1 Monday — Last date for an August graduate to submit camera-ready thesis manuscript to Graduate School Thesis Office
- 4 Thursday — Independence Day holiday
- 15 Monday — Last date for departments to certify to Graduate School completion of required papers for August graduates
- 15 Monday — Last date for an August graduate to deliver thesis to Graduate School Thesis Office
- 23 Tuesday — Last date for a prospective graduate student to submit completed application materials for admission to the fall semester 1985. An international applicant should submit materials at least three months before the beginning of the semester or session for which he or she is applying.
- 26 Friday — Last date for a graduate student to apply for permission to resume study in the fall semester 1985

### AUGUST

- 7 Wednesday — Classes end
- 8-10 Thursday to Saturday — Final examinations
- 9 Friday — Last date for an August graduate to resubmit *corrected* final copy of thesis to Graduate School Thesis Office
- 17 Saturday — Summer commencement

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NOTE: Students who plan to take examinations in French, German, and Spanish should apply through the Office of Graduate Programs, 211 Kern Graduate Building. Times and places of tests will be announced when the application is filed.

# GENERAL INFORMATION

## THE GRADUATE SCHOOL

### HISTORY

Graduate work at The Pennsylvania State University was first offered in 1862, but for some time there were few graduate students and graduate instruction was relatively unorganized. A committee of the General Faculty eventually was given the responsibility of establishing standards and regulations governing graduate work and the granting of master's and certain technical degrees. The Graduate School was formally established in 1922 by the President and the Board of Trustees. An administrative staff was organized, and the Graduate Faculty was formed. The University Senate delegated to this faculty responsibility for graduate affairs, subject to review. In 1924, the Board of Trustees authorized the granting of the degree of Doctor of Philosophy. On May 9, 1971, a Graduate Council was established for the Graduate School. Today graduate study is offered in 121 major programs, with 17 advanced academic and professional degrees being conferred. During the academic year 1981-82, 6,000 graduate students were enrolled and 1,721 advanced degrees were conferred, of which 404 were doctorates.

The Graduate School is a member of the Association of Graduate Schools (an organization within the Association of American Universities) and of the Council of Graduate Schools in the United States.

### THE GRADUATE FACULTY

The major role of the Graduate School is to emphasize those aspects of University activity which pertain directly to major programs in graduate study. Through its Graduate Faculty it represents a large segment of the academic strength of the University and is thus a dominant force in sustaining and furthering the intellectual quality of the entire institution. The eleven colleges of the University formulate study and research programs appropriate to their fields. The Graduate Faculty consists of those members of the college faculties who have authorization through the Graduate School to offer courses and seminars and supervise research and theses consistent with the highest academic standards. Thus, the Graduate School may be regarded as a federation of selected segments of the college faculties.

### THE GRADUATE COUNCIL

The governance of the Graduate School is vested in a Graduate Council, whose legislative authority is subject to the specific restrictions of the "Articles of Authority." The council forms its own standing committee structure under bylaws outlined in "Bylaws and Standing Rules of the University Graduate Council."

*The Committee on Committees and Procedures* recommends appointment of members of all other committees of the council and periodically reviews the committee structure and recommends changes as necessary.

*The Executive Committee* assists the council chairman in setting the agenda for council meetings and provides advice and counsel, as requested, to the dean of the Graduate School.

*The Committee on Academic Standards* recommends to the council criteria for membership in the Graduate Faculty, standards and policies for the admission of students, and thesis regulations and requirements. The committee also advises the council on problems of graduate training and professional development in the area of language and communication skills.

*The Committee on Programs and Courses* is responsible to the council for evaluation and review of new and existing graduate courses and programs.

*The Committee on Graduate Student and Faculty Affairs* is responsible for the review of new and existing policies concerning the welfare and professional ethics of the Graduate Faculty and graduate students, for the investigation of means to further the cultural, intellectual, and social welfare of the graduate community, and for assisting the council chairman in the review of appeals concerning violation of accepted norms of professional behavior of graduate students and faculty.

*The Committee on Fellowships and Awards* considers awards policies and judges applications for grants-in-aid, scholarships, and Graduate School fellowships.

*The Committee on Lecture Series* secures speakers and arranges for the Graduate School lecture series.

*The Committee on Graduate Commons and Related Matters* serves as liaison with the manager of



the Graduate Commons, the Graduate Student Association, and other groups in the University community that use the Commons facilities.

## ADMINISTRATION

Executive and administrative matters of the Graduate School are the responsibility of the dean, who is charged directly with enforcement of the regulations of the Graduate School and with organization of its administrative procedures. The dean has a major responsibility to enhance and insure the high quality of graduate study and research of graduate students. He exercises leadership in initiating new programs and in restructuring or phasing out marginal and obsolete ones. The dean encourages and assists in the development of multidisciplinary programs. He is assisted in this work by an administrative and clerical staff.

The main administrative offices of the Graduate School are located at University Park on the second and third floors of the Kern Graduate Building, named in honor of the late Dean Emeritus Frank D. Kern, who was the first dean of the Graduate School. There are five major administrative divisions in the Graduate School to which the student may go directly for answers to questions which require administrative assistance or decisions:

1. *Graduate Admissions*, 201 Kern Graduate Building. The Office of Graduate Admissions has responsibility for processing all matters pertaining to a student's admission.
2. *Graduate Student Programs*, 211 Kern Graduate Building. The functions of the Office of Graduate Student Programs encompass responsibilities for the academic involvement and concerns of all graduate students from the time they are admitted until they graduate, such as (a) registration of students, (b) readmission of students, (c) maintenance of records, (d) appointment of graduate committees for doctoral students, (e) scheduling of graduate student comprehensive and final oral examinations, (f) checking for accomplishment by students of Graduate Faculty requirements for all advanced degrees and preparation of official commencement lists, and (g) attention to student academic problems.
3. *Graduate Minority Affairs*, 308 Kern Graduate Building. The Office of Graduate Minority Affairs provides counseling and general assistance to prospective and enrolled minority graduate students.
4. *Graduate Fellowships*, 320 Kern Graduate Building. The Office of Graduate Fellowships serves as a clearinghouse for information on available fellowships and other awards for graduate students, administers fellowships and other award programs involving students in more than one college, and seeks support for graduate students attending the University.
5. *Theses and Publications*, 320 Kern Graduate Building. The Office of Theses and Publications is responsible for reviewing all theses to assure that they meet format requirements consistent with the attainment of high scholarly standards. The office prepares the major Graduate School publications.

## PROGRAM LOCATIONS

Programs of graduate study are offered at five locations in Pennsylvania:

**Behrend College** — The Behrend College at Erie provides convenient opportunity for graduate education to persons residing in northwestern Pennsylvania. It has been established to offer individual courses and a program leading to the degree of Master of Engineering with a major in Engineering Science.

**The Capitol Campus** — The Capitol Campus, located near Middletown and named for its proximity to the state capital, was opened in 1966. Graduate programs leading to the degrees of Master of Administration, Master of Arts with majors in American Studies and in Humanities, Master of Education with a major in Teaching and Curriculum, Master of Engineering with a major in Engineering Science, Master of Environmental Pollution Control, Master of Psychosocial Science, Master of Public Administration, and Master of Regional Planning with a major in Urban and Regional Planning are currently offered.

**The Milton S. Hershey Medical Center** — The University's Medical Center was established in 1963, and the first class of medical students entered in the fall of 1967. The center is located in Hershey, Pennsylvania, twelve miles from Harrisburg. In conjunction with The Pennsylvania State University's Graduate School, the College of Medicine offers programs leading to the Master of Science degree with a major in Laboratory Animal Medicine, and to the Doctor of Philosophy and Master of

## GENERAL INFORMATION

Science degrees with majors in Anatomy, Biological Chemistry, Microbiology, Pharmacology, and the intercollege programs in Genetics and Physiology.

**King of Prussia Center for Graduate Studies** — The King of Prussia Center for Graduate Studies near Philadelphia offers programs leading to the degrees of Master of Engineering with majors in Engineering Science and Industrial Engineering, Master of Public Administration, Master of Regional Planning with a major in Urban and Regional Planning, and Master of Education with majors in Mathematics, Elementary Education, and Special Education.

**University Park** — University Park, located in the municipality of State College in central Pennsylvania, is the largest of the Penn State campuses and offers 107 programs of graduate study.

## RESEARCH

Penn State faculty and their graduate student associates have long been recognized nationally and internationally for their accomplishments in basic and applied research. The construction of the field ion microscope, the development of an efficient process of no-till corn planting, and the creation of crownvetch, now widely used in controlling erosion on highway embankments, are all products of Penn State researchers. These accomplishments have been followed by other contributions, including advances in artificial insemination that have already saved farmers and consumers hundreds of millions of dollars, a surgical technique that dramatically reduces the death rate for infants suffering from a congenital heart defect, and inventions that vastly improve operation and monitoring of heart pacemakers. Research at Penn State, now funded at \$68 million annually, has led to specialized products, such as archaeological instructional films illustrated from excavations of a Mayan city, and to products with wide social utility, such as the knowledge, derived from failure tests, that a segmental bridge will carry ten times its design load.

In a typical year, about one-fourth to one-third of the patents pending or issued to University personnel name graduate students as coinventors. As one example, graduate student and faculty researchers at Penn State developed and patented a delayed-action mushroom nutrient, now sold throughout the country, that increases growers' yields by about 40 percent.

Other individual and ongoing research projects culminate in published contributions to the sciences, the humanities, and the arts. In a typical year, Penn State faculty, often with the collaboration of graduate students, produce more than twenty-five hundred books, technical papers, journal articles, stories, musical compositions, recordings, art works, and dramatic productions. *The Shaw Review*, *JGE: The Journal of General Education, Philosophy and Rhetoric*, *The Chaucer Review*, and *General Linguistics* are all published by the Penn State Press and edited by scholars who are members of the University's graduate faculty.

## RESEARCH FACILITIES

Of the University's more than sixteen thousand acres of land, a substantial portion consists of recreation areas, farms and agricultural experiment grounds, and forest tracts that are used by graduate students in their work and research. Animal and wildlife students, for example, are currently conducting nutrition and physiology studies of whitetail deer and blue duikers, a tiny African antelope, sheltered at one of the forest tracts. Astronomy students study at an observatory housing the largest telescope east of the Rockies. Those in civil engineering may carry out research at the only highway test track in Pennsylvania. Laboratories and equipment devoted to meteorology, mining, chemistry, biomechanics, engineering acoustics, psychology, and microbiology mirror the University's strengths in those disciplines. Recombinant DNA and microelectronics groups have also established themselves here, and centers of expertise in computer-assisted design and manufacture, as well as robotics, are emerging.

In addition to research conducted in academic departments or in organized research units within individual colleges, opportunities for interdisciplinary research exist in eight intercollege research units: the Applied Research Laboratory, the Center for Air Environment Studies, the Institute for Research on Land and Water Resources, the Laboratory for Human Performance Research, the Institute for Arts and Humanistic Studies, the Materials Research Laboratory, the Pennsylvania Transportation Institute, and the Institute for Policy Research and Evaluation. The Computation Center, the Health Physics Office, and the Laboratory Animal Resources Program are other intercollege units that provide university-wide services for instruction as well as research opportunities for graduate students.



## THE UNIVERSITY LIBRARIES

The University Libraries include a central collection, four subject branch libraries, and one reading room at University Park. Libraries are also located at Hershey Medical Center, Capitol Campus, King of Prussia Graduate Center, Behrend College, and at each of the seventeen two-year campuses.

At University Park, the central collection, the Arts Library, and the Life Sciences Library are all housed in the Fred Lewis Pattee Library. There are four branch libraries serving the Colleges of Earth and Mineral Sciences, Engineering, Science, and the Department of Mathematics; one reading room in the Department of Architecture; and the Pollock Library in an undergraduate dormitory area. In the reading room and branch libraries are books and journals needed for work assigned in the colleges. Included in the central collection are general reference books and periodicals, works in agriculture, biology, education and psychology, economics and business, the humanities, the natural and social sciences, maps, manuscripts, and government documents.

Among special collections are the Penn State Collection, a Joseph Priestley and a John O'Hara Collection, labor history archives, Audio Archives Collection, Australiana and Utopian literature, the Allison-Shelley Collection of Anglica Americana Germanica, music cassettes, microforms, and a rare book collection.

Special services include the Penntap Information System, which is housed in Pattee Library and serves industries, municipalities, and businesses in the Commonwealth. Several courses in library studies are offered each year by the faculty. In addition, a program of library instruction includes sessions provided as a part of regularly scheduled University courses in cooperation with the course instructors, and topical seminars by library faculty. General library orientation tours are offered at the beginning of each semester and summer session. Computerized literature searches of selected data bases in engineering, earth and mineral sciences, and in the physical, social, and life sciences are available through the General Reference Section and the related branch libraries.

For visually impaired and learning-disabled people, the Kurzweil machine, which converts print to recognizable voice patterns, is available for use in Pattee. Other equipment for the handicapped includes closed-circuit TV which enlarges print onto a video screen, and electronic aids, including calculators with synthesized speech capabilities. In cooperation with the Faculty Women's Club of State College, the University Libraries also provide tape-recorded text and text-related materials upon request.

Automation in the University Libraries has benefited all users. Lending, acquisition, and cataloging have been speeded up through computerized processes. At present, a computer output microfiche catalog known as COM updates the traditional card catalog, which no longer contains entries for most bibliographic material added to the libraries' collection since January 1981. Copies of the COM catalog with microfiche readers are available for use in locations throughout the library system. Meanwhile, the libraries' bibliographic records are being converted to computerized data which users will be able to access within the next few years by terminals located in the libraries and elsewhere at University Park.

The University Libraries are a member of numerous cooperative groups. They are one of the four Regional Library Resource centers established by Pennsylvania law and have memberships in the Association of Research Libraries, the Research Libraries Group, and the Pittsburgh Regional Library Center.

The libraries have approximately 2,360,000 cataloged volumes, 1,070,000 government documents, 23,500 serials, 253,000 maps, 2,075,000 microforms, 9,500 music cassettes and records, and over 2,000,000 other bibliographical items. Among the special resource guides issued by the library are *Newspapers in Microform*; *Pennsylvania Maps and Atlases*; *Australiana in The Pennsylvania State University Libraries*; *Guide to Sources in Black Studies in The Pennsylvania State University Libraries*; *Centre County, Pennsylvania: A Bibliography and Guide to Sources of Information*; *Literature and Politics in Latin America: An Annotated Calendar of the Luis Alberto Sanchez Correspondence 1919-1980*; *Voices and Events*, a catalog of audio tapes recorded on the University Park Campus; and the University Libraries Bibliographical Series. Newsletters from the General Reference and the Microforms sections provide up-to-date information on the libraries' resources and services.

## THE COMPUTATION CENTER

The Computation Center provides computing facilities and services for the instructional and research programs of all academic departments. Over 4,000 graduate students and faculty engaged in research and 15,000 undergraduate students doing class assignments use the Computation Center. The largest computer system is a sixteen-megabyte IBM 3081 processor, with six billion bytes of disk storage, a fifteen-thousand-reel tape library, and extensive computer software, including modern program lan-



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guage compilers and several thousand programs. There are 130 machine-readable data bases available, including hundreds of reels of tape from the 1970 and 1980 U.S. Census counts. The 3081 system supports batch processing with local and remote input-output equipment, and also supports 400 concurrent terminal users with interactive editors.

Networked with this system is a four-megabyte IBM 4341 processor with three billion bytes of disk storage, dedicated to full-function time-sharing interactive service, with a capacity of 100 concurrent users. Through an extensive data communication network, access to these systems is provided in the Computer Building, in the Computation Center's student laboratories in Boucke and Hammond buildings, at several other locations at University Park, and at twenty other campuses of the University.

Computer graphics services are provided by a number of time-sharing plotters, a high-precision Houston Instrument Plotter, a Versatec electrostatic printer-plotter, and a high-performance Evans and Sutherland Multi-Picture System for interactive graphics. Except for a few holidays, the Computation Center operates twenty-four hours a day, seven days a week.

## SPECIALIZED COMPUTING FACILITIES

The Pennsylvania State University seeks a balanced growth of both centralized and decentralized information and computation systems. Many academic computing facilities are now being developed to support the specialized research and instructional interests of the colleges and the intercollege research programs. Some of these specialized computing facilities are described below.

The Hybrid Computer Laboratory is operated as a facility for educational and research use of the entire University and is located in the Department of Electrical Engineering. This facility offers the user a hands-on environment to facilitate experiments in both hardware and software. This laboratory system consists of Digital Equipment Corporation's (DEC) KA-10 digital computer with 144 thousand (36-bit) words of high-speed memory and 25 million words of direct-access storage, and DEC's VAX 11/780 digital computer system, with 4 million bytes of high-speed memory and 667 million bytes of direct-access storage. Approximately forty-five terminals, ranging from sophisticated Vector Automation Graphic devices to simple CRT units, access either computer. A map digitizer, a photographic scanner, and A-D and D-A conversion on an EAI 693 analog computer support some of the engineering analog efforts within the College of Engineering. Extensive microcomputer software, including microprocessor operating systems and communications, have been developed within the laboratory. A major focus of the facility is the further support of graphics. Seven graphics packages now exist that provide user support, including three-dimensional and dynamic graphics. This laboratory is linked with the Computation Center, and many of the terminals can also access this University computational facility.

The Computer Systems Laboratory is maintained by the Department of Computer Science. The mission of the laboratory is to support the research and instructional activities of the department and the mathematical sciences. Research equipment in the laboratory consists of a Digital Equipment Corporation VAX 11/780 with 4 million bytes of internal memory and 1.2 billion bytes of disk storage. This system utilizes the powerful UNIX operating system (version 4.1) from the University of California, Berkeley. UNIX provides an interactive text editor, a flexible hierarchical file storage system, and compiler-compilers, and supports programming languages FORTRAN, PASCAL, APL, C, BASIC, and PDP-11 assembler. One important aspect of the laboratory's research efforts has been the development of computer networks. A Burroughs loop, utilizing an LSI 11/03 minicomputer as the controller, links three PDP-11 minicomputers, a Microdata 1630, a document printer, a line printer, and the VAX 11/780. The VAX super minicomputer, in turn, is linked with the Computation Center's IBM 3081 and 4341 so that files and jobs may be transferred between these systems. Terminals connected to the Computer Systems Laboratory network can also link with other researchers across the nation through USENET, BITNET, and the ARPANET. The instructional computing environment is developing from a concept of a microcomputer Student Work Station, which includes a CRT, CP/M, or UCSD PASCAL operating system, 64 thousand bytes of internal memory, a floppy disk, and 5 million bytes of hard disk for each unit. A set of eight stations will link with a PDP-11 node in the Burroughs loop. Immediate plans call for an eight-node prototype and a projected sixteen-node network.

The Chemistry Department Computing Center houses a PRIME 750 minicomputer with an array processor, 1 million bytes of internal memory, and 380 million bytes of disk storage. This system is dedicated to the research mission of the department and supports about ten faculty and fifty graduate students. Some of the present uses of the center include computer simulation of molecular fluids, analysis of the interaction of high-energy ions with solid surfaces, graphic-aided analysis, and pattern recognition.



The Meteorology Computer Facility utilizes a PDP 11/34 with 128 thousand words of internal memory for research and a VAX 11/730, with 1 million bytes of internal memory, for the real-time collection of weather data, weather forecasting, and the operations of the center. These computers access 169 million bytes of disk storage as of fall 1982. The Meteorology Computer Facility utilizes graphic routines to generate weather maps, special software for the collection of real-time satellite data relayed from Washington, D.C., UT 200 communications emulation to link with facilities such as the National Center for Atmospheric Research in Boulder, Colorado. This facility also links with the IBM computers at the Computation Center at Penn State.

The Milton S. Hershey Medical Center operates one large research computer facility containing DEC computers (VAX 11/780 and PDP 11/40) and an Evans and Sutherland graphics system. The center supports hands-on problem solving for a broad range of research interests in anesthesiology, biochemistry, behavioral sciences, clinical pathology, endocrinology, etc. Of particular interest is research in computer graphics and modeling of biological macromolecules. An Optronics microdensitometer, capable of 2-micron resolution, is available as part of the facility's instrumentation. The Hershey Medical Center also operates several smaller, dedicated computing facilities within individual departments.

The Materials Research Laboratory utilizes a dual processor PDP 11/20 to support a number of interactive terminals, real-time experiments, a communications link with the Computation Center, and a network of microcomputers. Much of the laboratory's computing orientation is in the development of microcomputer support for instrument-control, data reduction, and information analysis.

The Applied Research Laboratory (ARL) Computational Facility supports the research mission of ARL. Processing activities include real-time data acquisition and data analysis for the water tunnel, acoustic tank, etc. Approximately eighty research faculty and twenty graduate students utilize this facility each semester. Conversational programs support on-line CRT terminals for graphics, interactive problem solving, and text processing. The principal computing equipment of the facility is a DEC VAX 11/780 with 4 million words of internal memory and 900 million bytes of direct-access storage.

The Division of Special Education and Communication Disorders Research Center utilizes a DEC PDP 11/23 and several microcomputers to prepare instructional materials for handicapped children and adults, and to support research in communication disorders and special education. One aspect of the center's processing efforts focuses on the furthering of speech synthesis research.

Several colleges (e.g., Liberal Arts and Human Development) operate data laboratories that provide students and faculty with both batch and interactive access to the University's principal academic computers in the Computation Center. In addition to providing terminals, printers, plotters, etc., these laboratories are staffed to assist the users with application or programming problems. An important aspect of these professional services are the ongoing efforts to alert researchers to the growth of computing and information-processing tools that are being developed and incorporated into the facilities of the Computation Center.

## GRADUATE LIFE

Current graduate enrollment at University Park is about forty-eight hundred students, of whom 70 percent are engaged in graduate study full time, 34 percent are women, and 55 percent are residents of Pennsylvania. (Undergraduate enrollment at University Park exceeds 25,000.) International students comprise about 15 percent of the graduate student population, and about 5 percent of enrolling graduate students report themselves as members of recognized U.S. minority groups.

University Park is one of the most naturally beautiful American campuses. It is also one of the biggest. On any given day of the semester, about fifty thousand people will be on the campus: thirty-two thousand students, eleven thousand employees, and four to five hundred visitors. Although the size of the campus can be intimidating, graduate students soon find that the size and diversity of the campus afford a variety of stimulating activities. This variety reflects the University's view that a person's graduate experience should mean more than doing what is required in courses or in research. It should mean living in a scholarly atmosphere, profiting from the perspectives of visiting scholars and artists, and engaging in informal discussions with faculty and fellow students. It should also mean participating in student affairs and university governance, and allowing time to reflect, to explore fields related to one's specialty, and to recreate.

Although the mailing address of the main campus is University Park, PA 16802, this name ordinarily does not appear on maps. The University Park Campus is located in State College, Pennsylvania, a community with a resident population of about thirty-two thousand. State College is located on



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U.S. Highway 322, near Interstate 80, and can be reached directly by bus or airline service. The town retains a collegiate atmosphere enhanced by many small shops, restaurants, cinemas, and bookstores.

## GRADUATE STUDENT ASSOCIATION

The Graduate Student Association was established in 1951 as the representative body for graduate students, all of whom are automatically members, and is charged with designating graduate student representatives to a number of committees throughout the University. This volunteer organization provides graduate students with services, programs, and activities not otherwise available through the University. It also provides occasions for relaxation through its social programs. To help defray expenses, the association is partially funded through an allocation from Associated Student Activities, which is under the direction of the assistant vice president for student programs.

The Graduate Student Association Assembly, the legislative arm of the association, consists of elected delegates from every graduate department, with voting rights proportionate to the number of students in the department. Also included as voting *ex officio* members are the graduate students who have been elected to serve on the University Faculty Senate (4), the Graduate Council (5), and the University Council (1). All members of the University community are invited to attend the regular monthly meetings of the Association Council. An Executive Board, which consists of the executive officers and division heads, has interim powers to conduct business not requiring the specific action of the Association Assembly. The executive officers act as official liaison between the association and the dean of the Graduate School.

The Graduate Student Association has established the following divisions and standing committees: *Service Division*: (1) Garden Plots Committee, (2) Publication Committee, (3) Health Committee, and (4) Tax Committee; *Programming/Planning Division*: (1) Coffeehouse Committee, (2) Film Committee, (3) Speakers and Workshop Committee, and (4) Special Events Committee; *Academic Division*: (1) Rules Committee, (2) Research and Advocacy Committee, (3) Nominating Committee, and (4) Script/Interact Committee.

In addition, the Association Assembly may institute *ad hoc* committees and presidential commissions at will. Graduate students are eligible to serve on all committees of the Graduate Assembly.

The association maintains communication among its members through the campus daily newspaper, scheduled meetings and workshops, and informal use of the Graduate Commons. It publishes annually the *Guide to Graduate Life*, an informal introduction to both the University and the community.

The Graduate Student Association office is at 305 Kern Graduate Building (Tel. 865-4211). Graduate students are encouraged to bring any questions about graduate life to the office for informative, informal conversation.

## KERN GRADUATE COMMONS

The Graduate Commons, located on the first floor of Kern Graduate Building, provides programs, services, and facilities for the graduate community and serves as a common meeting area for faculty and students. The assembly room and multipurpose rooms are used for large group meetings; the smaller rooms are used for committee meetings and similar small group gatherings. These may be reserved by graduate organizations or for events of a University-wide nature.

Food service is provided by the Department of Housing and Food Service in the cafeteria and for special catered events. The lobby contains the Commons Gallery, which displays artwork done by students and faculty and exhibits from sources outside the University. The Commons serves as the home for Graduate Student Association programs such as the coffeehouse, films, concerts, and similar events. Policy governing building use and services is determined by the Graduate Council Committee on Graduate Commons and Related Matters.

The Office of the Director of the Graduate Commons serves as a clearinghouse for the scheduling of events planned by organizations and individuals. Reservations, a periodicals lending library (including daily newspapers), information regarding Graduate Commons activities, recreational equipment, and information of a general nature concerning the Graduate School are available at the Graduate Commons Information Desk. The Commons is open seven days a week during each semester and summer session. The operating hours are posted at building entrances. For further information call the Information Desk at 865-1878.



## INTERNATIONAL STUDENT AFFAIRS

The Office of International Student Affairs (OISA) and the International Student Lounge are located in 111 Kern Graduate Building. There are approximately 1,700 international students from 100 countries studying at the various University campuses. Over 80 percent of these students are enrolled in graduate programs.

Services of OISA include assistance with immigration regulations and tax information; academic, financial, and personal/adjustment counseling; emergency loans; billing for sponsored students; assistance in dealing with embassies, consulates, and sponsoring agencies; special orientation programs; program advising; mail service; housing information; job and travel information; home country employment information; an international student newsletter; advising many international student organizations; and sponsorship of activities.

The International Student Lounge is a comfortable place for international and American students to meet informally. All students are welcome to participate in OISA activities. Announcements of events are posted regularly in the lounge. OISA maintains a library of work/study/travel information, as well as other reading materials, including dictionaries, encyclopedias, maps, arts and crafts books, and many newspapers and magazines from around the world. The lounge is available for group meetings upon request.

The OISA works closely with the State College Community International Hospitality Council, a local community volunteer organization, and the International Council and its nineteen member international student organizations which represent international students at the University and promote a variety of social, cultural, and educational programs for the University community.

## RECREATIONAL AND ATHLETIC FACILITIES

At University Park there are six modern gymnasiums, sixty-five outdoor and four indoor tennis courts, six platform tennis courts, one outdoor and four indoor swimming pools, two eighteen-hole golf courses, an ice skating rink, twenty-six handball and paddleball courts, twenty-six bowling alleys, sixteen squash courts, indoor and outdoor running tracks, a baseball field, lighted intramural fields for football, soccer, rugby, and lacrosse, thirty-two acres of practice fields, and a four-mile jogging course. Rooms for weight training, fencing, archery, golf, body mechanics, dance, gymnastics, adaptive exercise, and wrestling are also available. The Stone Valley Recreation Area (located fourteen miles from University Park) provides sailing, boating, and picnic facilities. The wooded mountain country surrounding the campus offers outdoor recreation — swimming, boating, camping and trail packing, climbing, hiking, skiing, caving, and fishing.

## THE ARTS

Each year, the University Artists Series brings to the area many programs usually available only in major cities. The Fine Arts series and the Music series bring symphony orchestras, opera, chamber ensembles, choruses, and jazz and folk music artists to the University. The Theatre and Dance series and the Drama series bring touring professional companies to perform modern and classical dance, plays, and musicals.

University Theatre provides professional theater throughout the year. The University's performance facilities include a proscenium-thrust theater; an arena or three-quarter theater; a music recital hall; and two auditoriums, the larger seating twenty-six hundred.

The University Museum of Art galleries display traveling exhibits, as well as works selected from the permanent collection. Works in various media, including those of resident and student artists, are also displayed in the Kern, Chambers, Pattee Library, and Hetzel Union Building galleries.

The Graduate Student Association, the Artists Series, and several other student associations and interest groups regularly show classic and recent films on campus, complementing the first-run fare of the eight commercial cinemas in State College. The size of the institution enables student groups to sponsor concert appearances by first-rank performers.

## STUDENT SERVICES

The facilities and services outlined in the following paragraphs are available to graduate students.

### HOUSING AND FOOD SERVICE

Eastview Terrace and Graduate Circle, both located on the eastern side of the campus and within comfortable walking distance of most of the campus, provide one- and two-bedroom apartments for graduate students with families.

The Eastview Terrace apartments are fire-resistant, steel-framework, one-story buildings. There are 46 one-bedroom units and 30 two-bedroom units. Rent includes utilities (and TV cable) except for electricity and telephone. Water is heated electrically. The units are unfurnished except for electric stove and refrigerator. For each two units, there is a utility room with two stationary laundry tubs and storage space. Privately owned automatic washers may be installed in apartment kitchens only. No coin-operated facilities are available.

Graduate Circle has 144 one-bedroom apartments and 72 two-bedroom apartments in 16 two-story buildings of brick and frame construction. Rent includes all utilities (and TV cable) except for telephone. Each kitchen has a double stainless steel sink with disposal unit, a gas stove, kitchen cabinets, and an electric refrigerator. One bedroom has a built-in chest of drawers; otherwise, the units are unfurnished. There are no facilities for private washing machines in the apartments; however, ticket-operated laundries at nominal fees are provided in five of the buildings throughout the area. A basement storage locker is provided for each apartment.

Residence in Graduate Circle or Eastview Terrace Graduate Family apartments is limited to registered full-time graduate students who are candidates for advanced degrees. All students must live with their spouse and/or preschool children in the apartment. Families with children of school age (including kindergarten) or with children who will come of school age during the term of the lease cannot be considered for occupancy. The one-bedroom units are designed for a graduate student and spouse, and the two-bedroom units for a family with not more than two children. Rates and additional information can be obtained from the Assignment Office for Campus Residences, 101 Shields Building, University Park, PA 16802. Telephone: 814-865-7501.

Atherton Hall, located near the Hetzel Union Building, and McKee Hall, located near the Kern Graduate Building, are residence halls which provide combined room and board accommodations for single graduate men and women. Most assignments are made to double rooms since single rooms are available for only one out of three students. Rates for room and board for these halls can be obtained from the Assignment Office. The Hetzel Union Building and Graduate Commons restaurants, cafeterias, and snack bars also are available for meals.

All rates are subject to change by action of the University.

Information on other living accommodations available in the community may be obtained through:

The Graduate Student Association  
305 Kern Graduate Building  
The Pennsylvania State University  
University Park, PA 16802  
Telephone: 814-865-4211

The Organization of Town Independent Students  
20 Hetzel Union Building  
The Pennsylvania State University  
University Park, PA 16802  
Telephone: 814-865-6851

The State College Area Chamber of Commerce  
444 East College Avenue, Suite 210  
State College, PA 16801  
Telephone: 814-237-7644

Graduate students should arrange for their accommodations well in advance of the beginning of classes, because it may be very difficult to find convenient housing at the last minute. **STUDENTS MUST BE ADMITTED TO THE GRADUATE SCHOOL BEFORE THEIR REQUESTS FOR ON-CAMPUS LIVING ACCOMMODATIONS CAN BE PROCESSED.**



## UNIVERSITY HEALTH SERVICES

Located in the central campus area, the Ritenour Health Center is the core of the health service activities and is composed of a dispensary and a hospital. Its facilities are available to full-time graduate students qualifying for nonacademic student benefits and privileges; that is, students registered for 9 or more credits or the equivalent (students holding quarter-time, half-time, or three-quarter-time assistantships).<sup>\*</sup> The outpatient dispensary handles student medical problems from 8:00 to 11:45 a.m. and 1:00 to 4:45 p.m. daily except Saturdays, when hours are from 8:00 to 11:45 a.m. During other periods, including Sundays and holidays, patients are seen for emergencies only in the Emergency Room of the University Hospital, which is part of the Health Center complex. There is a \$7.50 emergency charge per visit.

The University Hospital is well-equipped to handle the more serious illnesses and injuries on an inpatient basis. A twenty-five-bed facility, it is staffed with professional personnel twenty-four hours a day during the school semesters. Should the need arise for special medical or surgical treatment — major surgery, for example — the student will be transferred to a personally chosen hospital facility.

Included in the Health Center facilities are a dental office for emergency dental care, a physiotherapy department, a pharmacy, and a nutrition clinic.

Hospitalized students will be charged \$50 per day during confinement, and a nominal charge will be made for X-rays and all drugs dispensed to hospital or dispensary patients. Consultation with or treatment by physicians other than the professional staff at the Health Center is at the student's expense. All accounts should be settled before the end of the semester or session in which charges were incurred.

The Ritenour Health Center maintains an ambulance service for local transportation of students with nonambulatory illnesses and injuries.

## HEALTH INSURANCE

Low-cost medical insurance is available for full- and part-time graduate students, including non-degree students, and their dependents. Information concerning the specifics of the policy can be obtained by contacting the Graduate Student Association, 305 Kern Graduate Building, University Park, PA 16802 (Tel. 865-4211).

## MEDICAID BENEFITS

Graduate students may qualify for most of the benefits that apply to hospitalization and medical treatment under Medicaid. Graduate students who are permanent residents of Centre County may apply for state medical assistance to the Office of the Centre County Board of Assistance, Bellefonte, PA 16823 (Tel. 355-5531).

## HEALTH SERVICES FOR CHILDREN

Many medical services are available for children under twenty-one through the State Health Center. The services range from simple immunizations to complicated surgery. Diagnostic study and consultation at the center are made regardless of the ability to pay; however, not all services are free. Children may be referred to the center by physicians or health and welfare agencies. Any preschool child is eligible for free well-child examinations and immunizations. For additional information, contact the Health Center at 110 South School Street, Bellefonte, PA 16823 (Tel. 355-5438), or consult your doctor.

## CAREER DEVELOPMENT AND PLACEMENT CENTER

The Career Development and Placement Center provides counseling and placement services to assist students in their development and in formulating and implementing both short- and long-range career plans.

Some of the specific services and programs offered by the center include:

**Counseling Services** — Counseling staff are available to meet with students both individually and in groups to assist with educational and vocational concerns. Standardized test data, information resources, and educational programs described below are often employed to help a student assess his or

<sup>\*</sup>Eligibility is determined by the Graduate School when the I.D. cards are issued.

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her own abilities, attitudes and values, interests and aptitudes, and to relate these to job and career opportunities so that the student can make appropriate educational and vocational plans.

**Educational Programs** — The center offers opportunities for students to participate in programs designed to develop specific skills such as decision making, personal planning, and assertiveness training.

**Career and Employer Information Library** — The library includes an extensive file of general and specific information on careers and academic majors, information about employers, and a variety of other resources to assist students in choosing a program of study and a suitable career.

**Placement Services** — The center cooperates with the colleges and departments of the University to assist students in implementing career plans upon graduation. Services include (1) a library containing information on career opportunities, employer characteristics, and graduate and professional schools; (2) scheduling interviews with prospective employers who are visiting the campus; (3) a file of employment opportunities for which a student may apply by mail; (4) a listing of career-related summer jobs and internships; (5) workshops in interviewing skills, résumé preparation, and job search strategies; (6) a variety of informational meetings and publications.

The center is located on the fourth floor of Boucke Building (Tel. 863-0225).

## VETERANS OUTREACH OFFICE

The Veterans Outreach Office, 135 Boucke Building, provides information on programs and services unique to veterans (see Veterans' Benefits, page 32).

## TUITION AND CHARGES 1982-83

The University reserves the right to revise the schedule of tuition and charges without further notice. At the time this catalog went to press, tuition rates for 1983-84 had not been established. Beginning in fall 1983, the University's academic calendar is based on two 15-week semesters and an 8-week summer session. Tuition rates for 1982-83, shown below, are rates for one 10-week term of study under an academic calendar consisting of four 10-week terms per calendar year. Prospective students are cautioned specifically against using 1982-83 term tuition rates to estimate the cost of semester and summer session tuition in 1983-84.

### TOTAL TUITION FOR EACH TERM IN 1982-83

**University Park Campus and Medical Center (Nonmedical Students)** — 8 or more credits, total charge of \$752 for Pennsylvanians and \$1,504 for non-Pennsylvanians; 7 or fewer credits, \$94 per credit for Pennsylvanians and \$188 for non-Pennsylvanians. These rates apply also for off-campus research and other approved individual study.

**Behrend College, King of Prussia Graduate Center, and Capitol Campus** — 8 or more credits, total charge of \$706 for Pennsylvanians and \$1,504 for non-Pennsylvanians; 7 or fewer credits, \$87 per credit at Behrend, \$115 per credit at King of Prussia, and \$89 per credit at Capitol for Pennsylvanians; \$188 per credit at all locations for non-Pennsylvanians.

**Continuing Education Center** — Tuition for continuing education courses carrying graduate credit will be charged at the prevailing rate at the campus where the courses are offered.

**Vocational Education Program** — 8 or more credits, total charge of \$752 for Pennsylvanians and \$1,504 for non-Pennsylvanians; 7 or fewer credits, \$94 per total program for Pennsylvanians and \$188 for non-Pennsylvanians (vocational education courses are indicated by "v" following the course number).

Tuition is the same for courses whether audited or taken for credit.

Any student who does not fulfill payment obligations promptly may be charged a late payment fee of \$25. A student whose account is delinquent for more than ten days is subject to suspension from the University.



**Residency** — When it appears that an applicant for admission is not a resident of Pennsylvania for tuition purposes, a non-Pennsylvanian classification is assigned. If the student who is thus admitted believes that circumstances do not justify classification as a non-Pennsylvanian, a petition can be made to the Financial Officer for the Dean of the Graduate School, 316 Kern Graduate Building, University Park, PA 16802, for reclassification. (See Student Pennsylvania Resident Status, page 35.)

## TUITION REFUND POLICY

Charges for tuition are refundable upon withdrawal from the University only in the event the student obtains an official Withdrawal Form at the Office of Graduate Student Programs and presents it, together with a current Certificate of Registration, at the Office of the Fee Assessor no later than one calendar month after the effective date of withdrawal from classes. Students who meet these conditions are entitled to receive refunds of charges for tuition for the semester, in accordance with the following schedule:

Refund of 80 percent upon withdrawal before the end of the first week of the semester (seventh consecutive calendar day from the first day of classes) and a decrease of 10 percent for each week thereafter, up to and including the eighth consecutive calendar week. No amount will be refunded for withdrawal after the eighth consecutive calendar week of the semester.

Under this policy, if a student is enrolled for 12 or fewer credits and drops 1 or more credits, refunds will be determined in accordance with the above policy.

The University will not release any refund of tuition until at least three weeks have elapsed from the date the payment was received. All refunds will be made by check and mailed to the student's home address.

## SPECIFIC CHARGES

In addition to the foregoing tuition and charges, the following charges apply under special conditions and are to be paid independently:

Application fee .....	\$25.00
Change of schedule (each change after first five working days of semester) .....	6.00
Duplicate meal ticket .....	2.00
Duplicate student identification and activity card .....	each 5.00
Music, individual lessons .....	40.00 to 100.00
Privilege of late payment .....	25.00
Privilege of late registration .....	10.00
Special Ph.D. thesis preparation registration fee (601, 611) .....	158.00
Student parking fee, each semester .....	15.00
Teacher placement service registration fee .....	10.00
Teacher placement service reactivation fee .....	10.00
Thesis microfilming and binding fee for master's candidate (one copy) .....	12.50
Thesis microfilming and binding fee for doctoral candidate (one copy) .....	40.00
Transcript of records (with seal), each copy .....	2.00
Mailing diploma in absentia .....	5.00

A student's transcript, diploma, or both, may be withheld until any outstanding financial obligations to the University have been paid.

## STUDENT AID

There are four separate avenues for graduate students to explore when seeking financial assistance. Most aid is awarded by the academic department, the Graduate School, the Office of Student Aid, or external agencies. The process for aid consideration is decentralized; consequently, it is necessary to file separate applications with each office.

The deadlines for submitting financial aid applications vary with each area and often occur prior to the final deadline for submitting an admission application. Early application for financial aid is recommended as these applicants are the most likely to receive favorable consideration. It is often desirable to apply by the first week in February for the succeeding year. It is best to apply for all sources of aid simultaneously, not sequentially in order of your preference. If you file sequentially in order of

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your preference, you may not get your first choice and then have also eliminated yourself from other alternatives due to missed deadlines.

In all cases where a student is seeking financial assistance through the University, an admissions application should also be filed, because no formal action can be taken on financial aid until an offer of admission is approved.

The principal sources of financial assistance appear below.

## ASSISTANTSHIPS

Approximately 2,200 graduate assistantships are awarded annually. An appointee may serve as an assistant in classroom or laboratory instruction, in research, or in other work.

*A prospective student should write directly to the person in charge of the intended graduate major program for information and application forms.* Appointments are made subject to the student's admission to the Graduate School as a degree or certificate student. Clear evidence of superior ability and promise is required. Reappointment to an assistantship is based on availability of positions and the quality of the student's work. In most departments or major programs the number of years an appointment may be renewed is limited.

The assistantships vary as follows:

**QUARTER-TIME** — The student normally schedules 11 to 14 credits per semester, receives a stipend plus a grant-in-aid of resident education tuition, and is assigned tasks which, on the average, occupy approximately ten hours per week.

**HALF-TIME** — The student normally schedules 8 to 11 credits per semester, receives a stipend plus a grant-in-aid of resident education tuition, and is assigned tasks which, on the average, occupy approximately twenty hours per week.

**THREE-QUARTER-TIME** — The student normally schedules 6 to 8 credits per semester, receives a stipend plus a grant-in-aid of resident education tuition, and is assigned tasks which, on the average, occupy approximately thirty hours per week.

The credit load limits specified above may be increased or decreased for a specific semester by permission of the assistantship supervisor, provided the total work load is properly balanced in each semester and the total credit load over a series of semesters is in conformity with the guidelines stated above. Work assigned as a part of assistantship duties for which academic credit is granted need not be counted as a part of the credit limits stated above.

A graduate assistant may accept concurrent employment outside the University only with permission from the assistantship department head and the assistant's graduate academic program chairman. Concurrent employment normally may not be held with the University. A student may receive a concurrent fellowship supplement.

A graduate assistant pays no fee for the privilege of driving and parking on the campus but is required to comply with student regulations concerning motor vehicles.

## FELLOWSHIPS AND TRAINEESHIPS

About 250 fellowships and traineeships are awarded annually. Recipients must be superior students and are sometimes required to have completed a certain minimum of graduate work before being eligible for an award. Need is also frequently a consideration. Fellows and trainees are required to carry a minimum of 12 credits of course work each semester or the equivalent in research, receive stipends which vary with the awards, and usually receive grants-in-aid of tuition. They may not accept employment during the period of their appointments (except with special permission for training purposes) nor are they required to render any service to the University. In some cases a recipient will be expected to engage in research in a broad field specified by the donor. There is no sharp distinction between a fellowship and a traineeship. Scholarly excellence is always a major consideration and usually the most important criterion in selecting fellowship recipients. Other considerations commonly come first in awarding traineeships.

**Graduate School Fellowships** — A number of fellowships, each paying a stipend of up to \$550/month and providing a grant-in-aid to cover resident education tuition charges, are given by the University and are designated as Graduate School Fellowships. They are available to outstanding graduate students working toward a Ph.D., D.Ed., or M.F.A. degree.

Application forms may be obtained from the Graduate School Fellowship Office, 320 Kern Graduate Building. Applications must be submitted through the applicant's graduate major program and



must be received by the Graduate School by the first Monday in February to be considered for the following year. Graduate Record Examination verbal, quantitative, and analytical test scores are required of all applicants.

**Special Graduate School Fellowships, Fellowship Supplements, and Grants-in-Aid** — These are open only to students who have been approved for admission but are not yet enrolled in the Graduate School at the time of application. Full fellowships pay up to \$520/month plus resident education tuition. Grants-in-aid provide only tuition. Supplements are small grants in addition to a graduate assistantship or another fellowship. Some supplements are in the form of low-interest loans. Application forms may be obtained from the Fellowship Office, 320 Kern Graduate Building, University Park, PA 16802, and must be submitted through the person in charge of the applicant's graduate major program so as to reach the Graduate School by mid-February to be considered for the following fall. Applicants must arrange to have Graduate Record Examination verbal, quantitative, and analytical test scores sent to the Graduate School by the application deadline.

**Minority Graduate Scholars Awards** — These are fellowships, assistantships, and fellowship supplements granted as a part of the University's comprehensive educational opportunity program. Stipends and qualifications are the same as for other fellowships and assistantships. For further information contact the Graduate School Fellowship Office, 320 Kern Graduate Building.

When a graduate assistantship, fellowship, grant-in-aid, or scholarship for the next academic year is offered, the student, if acceptance is requested before April 15, will have complete freedom through April 15 to submit in writing a resignation of the appointment in order to accept one elsewhere. However, an acceptance given or left in force after April 15 commits the student not to accept another appointment without first obtaining a formal release.

Selection of recipients of all University awards is made without regard to the sex, race, religious belief, or ethnic origin or handicap or age of the applicant, as provided by law.

**External Fellowships and Traineeships** — Over 100 such awards, with various stipends, are granted through individual departments and state and national organizations. These awards are shown with the pertinent graduate program description under GRADUATE PROGRAMS, FACULTY, AND COURSES in the Graduate Bulletin. Information and application forms may be secured from the person in charge of the appropriate graduate program. Specific awards will vary somewhat from year to year.

In addition, grants are available from governmental agencies, industrial concerns, foundations, and the armed forces for graduate study and frequently for support of investigations of particular problems. Detailed information may be secured from the department of specific interest. Lists of funding opportunities are available in the Graduate Fellowship Office, 320 Kern Graduate Building. Information on external funding opportunities is also available in the reference areas of the libraries. Directories that may be helpful are the following:

*Financial Aids for Higher Education* (Oreon Keeslar)

*Annual Register of Grant Support* (Marquis Academic Media)

*Educational Financial Aids* (American Association of University Women)

*A Selected List of Major Fellowship Opportunities and Aids to Advanced Education for U.S. Citizens* (National Science Foundation)

## OTHER AIDS

**Graduate School Tuition Grants-in-Aid** — A number of grants of tuition remission for a semester of full-time study are awarded each year. Applications are available to any graduate degree or certificate student during or after the second semester at the University. Financial need and academic promise are the criteria for selecting recipients. A recipient must carry 12 to 18 credits of graduate work but may accept employment of not more than ten hours per week with the University or another employer. Summer session tuition grants-in-aid, to a maximum of 9 credits, are available. Preference is given to graduate assistants who have had an appointment during the immediately preceding two semesters. Applications for grants for the fall and spring semesters and summer sessions must be filed by the third week of the preceding semester or session and by early April for the fall semester. Application forms and information on application deadlines may be obtained from the Graduate School Fellowship Office, 320 Kern Graduate Building.



**The Ruth Young Boucke Graduate Fellowship** — Established from the estate of Ruth Young Boucke, whose husband was for many years a professor of economics, this fellowship is available every other year to an outstanding graduate student on the same basis as the regular Graduate School fellowships, and selection is made by the Graduate School Committee on Fellowships and Awards. The stipend is up to \$600 per month plus a grant-in-aid of the thesis preparation fee.

**The United States Steel Foundation Loan Fund** — This fund provides loans for emergencies and to supplement fellowships. Recipients must be U.S. citizens who are enrolled full time in graduate programs in the Colleges of Earth and Mineral Sciences, Engineering, or Science. Further information may be obtained from the Graduate School Fellowship Office, 320 Kern Graduate Building.

**Employment and Loan Programs Available Through the Office of Student Aid** — Any prospective or current graduate degree candidate who is a U.S. citizen or permanent resident may seek aid from the federally funded loan and employment programs listed below directly through the Office of Student Aid, 335 Boucke Building.

To be considered for these aid programs, a prospective graduate student must

1. file by February 15 a Financial Aid Form (FAF), a document used to assess a student's financial need, with the College Scholarship Service, Box 176, Princeton, NJ 08540 or file a Graduate and Professional School Financial Aid Summary (GAPSFAS) with the Educational Testing Service, Box 2614, Princeton, NJ 08541.
2. file by April 1 an Application for Financial Aid and a Financial Aid Transcript with the Office of Student Aid. For each postsecondary institution the student has attended, a separate Financial Aid Transcript, certified by that institution, must be submitted. This form is available from the Office of Student Aid.

On-time applications receive first consideration. Because funds are limited, applications filed after the deadlines are considered only as funds permit. Aid is never automatically awarded for subsequent years. Students must reapply each year for funds. Students planning to attend during the summer must file separate applications.

**THE GRADUATE WORK-STUDY PROGRAM** is a part-time employment program awarded to graduate students who show a documented financial need. Responsibilities and assignments are similar to those associated with graduate assistantships. This type of aid is rarely available to a student who accepts a graduate assistantship because of the difficulty of holding two jobs concurrently and the potential for a student's total aid resources to exceed his or her documented financial need.

**THE NATIONAL DIRECT STUDENT LOAN (NDSL) PROGRAM** makes low-interest loans available to full-time students with a documented financial need. Repayment begins six months after graduation or termination of graduate work at a 5 percent interest rate.

**UNIVERSITY LOANS** are funds established by University organizations, alumni, faculty, staff, and friends to help students who have a documented financial need. Repayment begins immediately upon graduation or termination of study. The maximum loan for one year is \$5,000. Interest at the rate of 9 percent will accrue throughout the in-school period.

**THE GUARANTEED STUDENT LOAN (GSL) PROGRAM** provides low-interest loans to students enrolled on at least a half-time basis. The loans are repayable after the student graduates or terminates his or her education. This federal financial aid program is a cooperative effort of the federal government, state government and/or guarantor agency, a commercial lending institution, and the educational institution.

An application should be obtained from a lending institution which agrees to participate with the student in this program. The loan is available on an interest-free basis to students during their graduate enrollment. Dependent students from families with an "adjusted gross income" of \$30,000 or more and independent students with an "adjusted gross income" of \$30,000 or more must file a Need Analysis document to determine their financial need for GSL funds. Additional information about this process and about the Auxiliary Loan to Assist Students may be obtained from the Office of Student Aid. While enrolled, a student's interest payments on the outstanding loan principal are paid by the federal government. A graduate student may borrow up to a total of \$25,000, including any Guaranteed Student Loans received for undergraduate study. The maximum loan for one year is \$5,000. For students who are first-time GSL borrowers and acquire loans for a period of enrollment after January 1, 1981, the interest rate will be 9 percent. GSL borrowers with previous 7 percent loans will



continue to receive additional loans at the 7 percent interest rate. A 5 percent origination fee is deducted from each GSL by the lender.

When seeking aid, the prospective student should keep in mind the following:

**Cost of Attendance** — In determining a student's need in 1981-82, the Office of Student Aid used the following estimates of expenses for an academic year (at that time, three 10-week terms) as a basic guide. (Estimates are increased for students with dependents.)

	<i>PA Residents</i>	<i>Non-PA Residents</i>
Tuition	\$1,968	\$3,936
Room & Board	2,610	2,610
Books and Miscellaneous	1,968	1,968
Total Estimated Cost	<u>\$6,546</u>	<u>\$8,514</u>

In 1981-82, tuition for Pennsylvania residents at Behrend, Capitol, and King of Prussia was \$1,848.

**Nondegree Students** — Financial aid is available for graduate students who are degree, provisional, and certificate students only. Nondegree graduate students are not eligible for assistance.

**FEDERAL STUDENT ASSISTANCE SATISFACTORY ACADEMIC PROGRESS STANDARD** — Satisfactory academic progress must be maintained for continued consideration for federal financial assistance at Penn State. Students must comply with the following to insure continued consideration:

1. Meet minimum standards for satisfactory scholarship as established by the University Graduate Council presented in *The Pennsylvania State University Bulletin, Graduate Degree Programs*.
2. Meet minimum semester earned credit level expectations as published in the 1983 Penn State *Student Handbook*. Copies of the academic standards are available from the Office of Student Aid in handbook form.
3. Complete the requirements for the graduate degree within the time frame as indicated in the Graduate Bulletin.

Exceptions to the above and information concerning reinstatement of aid, course audits, deferred grades, and course repeats may be obtained by contacting the Office of Student Aid.

Additional information may be obtained from the Office of Student Aid, 335 Boucke Building, University Park, PA 16802. In corresponding with this office, specify that you are a current or prospective graduate student, and if the latter, the semester or summer session you wish to begin graduate study at the University.

## GUIDELINES FOR TOTAL ALLOWABLE RESOURCES

Fellowships and assistantships are offered with the provision that permission must be granted from the first awarding department/agency before a second fellowship or assistantship can be held simultaneously. Guidelines used for determining if a second appointment is allowed are:

- a. For assistantships or fellowships based on financial need, the combined total may not exceed the tuition plus the stipend paid a grade 6 half-time graduate assistant.
- b. For assistantships or fellowships awarded without financial need as a criterion, the combined total may not exceed the tuition and stipend paid to a grade 14 half-time graduate assistant.

Federal aid recipients are under federal regulations which supercede the above guidelines.

If a student receives a Guaranteed Student Loan, a National Direct Student Loan, or Graduate Work Study, federal regulations require that the total financial aid resources not exceed the student's documented need. If the total aid exceeds the need figure, it may be necessary for an adjustment in federal and/or University funds. If an adjustment is not possible because the funds have been used by the student, an overaward results. In the case of an overaward, a student may be required to repay federal and/or University funds which exceed the documented need. Students with graduate assistantships or fellowships who receive federal aid during the same academic year (including summer) should be careful to adhere to these regulations. For additional details on these programs, contact the Office of Student Aid, 335 Boucke Building, University Park, PA 16802.

**Girard Edu-Check Plan** — The University offers to sponsors (including parents) of students the Assured Education Plan, enabling them to pay out of current income, on a monthly basis, University bills for tuition, residence hall room and board, and all other items billed by the University. Life insurance and total and permanent disability insurance are a part of the plan for the sponsor up to the sixty-eighth and sixty-first birthdays, respectively. Payments are handled through the Girard Bank, 1339 Chestnut Street, Philadelphia, PA 19107. Further information and application forms may be ob-

tained from the Office of the University Bursar, 103 Shields Building. Signed agreements should be received well in advance of registration for classes, since it takes at least three weeks for completion of arrangements.

**Student Employment** — Many students depend upon part-time employment to help meet their expenses. Students must recognize the time demands of their work schedules and adjust their academic loads accordingly. The Office of Student Employment, 301-A Boucke Building, offers assistance in finding part-time employment in the State College community, as well as on campus. This office assists students in finding summer employment. The Office of Student Aid coordinates the Graduate Work-Study program, described above under Loan and Employment Programs.

Local placement services and the University Office of Personnel maintain files of positions open to spouses of students.

A student holding a fellowship or traineeship may not accept employment of any kind for service without special advance approval. A graduate assistant may accept concurrent employment outside the University only after obtaining permission from the department head and person in charge of the major program. Concurrent appointments with the University other than a Fellowship Supplement normally may not be held.

**Veterans' Benefits** — The coordinator of veterans affairs has the responsibility of handling all applications for benefits under the various public laws. Veterans who intend to enroll at the University should contact the Veterans Outreach Office, 135 Boucke Building, University Park, PA 16802, as far in advance as possible to obtain information and necessary forms. The Outreach Office also provides information on other programs and services unique to veterans.

Under P.L. 89-358, a student is entitled to benefits if registered as a full-time student, unless the department head certifies that fewer credits constitute a full-time academic load for that student (see Full-Time Academic Status, page 41).

At each registration, a special veterans (V) card must be submitted to confirm enrollment and academic status. Submission of this card does not generate benefits which are not already certified, but failure to submit the card results in immediate interruption of VA benefits.

Veterans in their first semester may defer tuition and room and board fees until their benefit checks begin to arrive. Veterans who need this deferral should contact the veterans counselor, 135 Boucke Building.

Federal law and Veterans Administration regulations specify the conditions under which veteran students and eligible dependents are paid VA educational benefits. Veterans Administration benefits are paid under the standards of academic progress and policies relating to student conduct contained in this bulletin and which apply to all graduate students. In addition, certain special conditions for payment of VA educational benefits must be met:

1. Courses which do not meet graduation requirements in the student's approved major (the major which the student has declared to the VA) cannot be computed as part of the student's course load for payment of VA benefits.
2. Unless mitigating circumstances exist, VA benefits cannot be paid for attendance of any portion of a course or semester that is not completed.
3. Unless *specific documentation* of an identifiable professional or academic goal can be provided (e.g., teachers requiring 24 graduate credits to obtain permanent certification), no veteran or eligible dependent may be certified for payment of VA educational benefits for any semester subsequent to one during which he or she accumulates 18 credits on a nondegree status.
4. Since a 3.00 cumulative grade-point average is required for graduation, graduate student veterans and eligible dependents will be warned that their VA educational benefits may be suspended if their cumulative grade-point average falls below 3.00 during any given semester. If the student's average remains below 3.00 for a second consecutive semester, the VA certifying official will request a determination of whether progress has been satisfactory from the appropriate department head. If it has not, the VA certifying official will suspend benefits and report the veteran to the VA for lack of satisfactory progress.
5. Veterans and eligible dependents must report any change in academic status (change of credit load, change of major, etc.) to the Office of Veterans Affairs or other appropriate VA certifying official promptly and personally.



# APPLICATION AND ADMISSION PROCEDURES

## STATEMENT OF NONDISCRIMINATION

The Pennsylvania State University, in compliance with federal and state laws and regulations governing affirmative action and nondiscrimination, does not discriminate in the recruitment, admission, and employment of students, faculty, and staff in the operation of any of its educational programs and activities as defined by law. Accordingly, nothing in this publication should be viewed as directly or indirectly expressing any limitation, specification, or discrimination as to race, religion, color, or national origin; or to handicap, age, sex, or status as a disabled or Vietnam-era veteran, except as provided by law. Inquiries concerning this policy may be directed to the vice president for student affairs.

## ADMISSION

Each step of the educational process, from admission through graduation, requires continuing review and appropriate approval by University officials. The University, therefore, reserves the right to change the requirements and regulations contained in this bulletin and to determine whether a student has satisfactorily met its requirements for admission or graduation, and to reject any applicant for admission for any reason the University determines to be material to the applicant's qualification to pursue higher education.

An applicant for admission to the Graduate School should understand that graduate work is not a simple extension of an undergraduate program but, rather, demands scholarship of a higher order, and emphasizes research, creativity, and professional competence with a minimum of formal requirements and a maximum of student initiative and responsibility.

**Objective** — The objective of the Graduate School is to admit a qualified graduate student body up to the limit of the University's resources to provide outstanding graduate programs. In general, a student may begin graduate work in the fall or spring semester or in the summer session.

Applicants must recognize that staff, facilities, and other resources are limited, so that not all qualified persons can be admitted. The number accepted will vary by program, and from semester to semester. In some graduate programs all vacancies will have been filled long before the general Graduate School deadline for submitting applications, so that even outstanding students cannot be accepted.

**Application** — Applicants interested in graduate programs offered at University Park or The Milton S. Hershey Medical Center should apply to University Park. Those interested in programs at the Capitol Campus, the King of Prussia Center for Graduate Studies, or the Behrend College should apply directly to the appropriate campus. Students are normally expected to begin work at the campus to which they are admitted (see Special Interdisciplinary Majors, page 37).

**Qualifications** — For admission to the Graduate School, an applicant must have received, from an accredited institution, a baccalaureate degree earned under residence and credit conditions substantially equivalent to those required by The Pennsylvania State University. Ordinarily, an entering student must have completed in a satisfactory manner a minimum of course work in designated areas, the specific courses and amount of work depending upon the field of advanced study. Scores on the Graduate Record Examination (GRE) Aptitude Test (verbal, quantitative, and analytical) are required by the Graduate School for *completion* of the admissions process. Whether they are required *prior to acceptance* at Penn State depends on the admission requirements of the individual graduate program, which should be consulted. Students who enroll without GRE scores on record will be classified as provisionally admitted and will be requested to take the GRE within one semester of enrollment. The student provisionally admitted at University Park must take the GRE at University Park when it is offered during his or her first semester. A student registered in a degree program for the first time for summer session without GRE scores will have until December 1 to submit the scores whether or not he or she attends on a summers-only basis. Individual graduate programs and departments may require Advanced Test scores. The GRE is offered at convenient locations, several times each year.

A baccalaureate degree holder with a slight deficiency in undergraduate preparation may be admitted and allowed to schedule a limited number of undergraduate courses to remove the deficiency



while proceeding in the graduate program. Courses taken for this purpose do not apply toward the requirements of the advanced degree.

**Provisional admission** may be granted to applicants whose credentials are not complete at the time of application because the baccalaureate degree has not yet been conferred, grades for the current semester are not yet available, GRE scores have not yet been reported, etc. Such admission is subject to cancellation if the complete credentials, on arrival, do not meet the requirements for admission. In the interim, certification of any earned credits will be withheld. If admission is canceled for any reason, the student is thereby automatically dropped from the Graduate School. Completion of admission in such cases is dependent upon receipt of the missing credentials (see Provisional Admissions, page 36).

Admission is granted jointly by the Graduate School and the department or graduate program in which the student plans to study. The establishment of standards by which applicants are admitted is a departmental or program responsibility. Although the Graduate School has no fixed minimum grade-point requirement for admission, an applicant is generally expected to maintain a junior-senior grade-point average of at least 2.50 on The Pennsylvania State University grading scale of A (4.00) to D (1.00). Individual programs may establish higher grade-point average requirements and use other criteria to judge candidates for admission. In exceptional cases, departments or major programs may also approve admission by reason of special backgrounds, abilities, and interests. Departmental or program requirements are given in the descriptive statements appearing under the graduate programs listed in the latter part of this publication.

A student who has been admitted to a program in which the doctorate is offered may begin working toward that degree but has no official status as a doctoral student and no assurance of acceptance as a doctoral candidate until a candidacy examination administered by the major department or committee has been passed.

**Forms** — Application forms may be obtained from the Office of Graduate Admissions. Applicants may apply for admission to only one program at a time. All academic records, including an explanation of the grading system used, should be submitted, *in duplicate*, to the Office of Graduate Admissions, 201 Kern Graduate Building. These must be received from all institutions by the Graduate School at least one month prior to the opening of the semester or summer session in which the student plans to begin a graduate program.

**Deadlines** — The deadline for processing of applications by the Graduate School is one month prior to the beginning of any given semester or session. GRADUATE MAJOR PROGRAMS MAY REQUIRE EARLIER DEADLINES. A complete Graduate School admissions file, which is required for processing an application, includes the following items: (1) application form, (2) application fee form, (3) a check or money order in the amount of \$25.00 made payable to The Pennsylvania State University, and (4) duplicate transcripts from each institution of higher education attended. Supplementary materials and examination scores may be required in individual programs. If the admission file is incomplete a month prior to the beginning of the semester or session for which the student has applied, the materials will be processed for the first semester or session following the completion of the admissions file.

**Special Nondegree** — A student who plans to take courses for transfer to another institution or to follow a program of study not leading to an advanced degree at this institution should apply for admission as a special nondegree student. The adviser for such a student is appointed by the Graduate School. The number of special nondegree students who can be admitted is limited because preference is given to students in degree programs.

**Minority Students** — Minority students are encouraged to apply for admission to any of the programs offered in the Graduate School. Information concerning programs and financial aid may be obtained from the chairman of the graduate program or the dean of the college of the student's major interest.

**International Students** — International students should plan to apply at least three months prior to the beginning of the semester or summer session in which they intend to begin graduate studies. They must submit, *in duplicate*, certified English translations of all academic records. In addition, all international students whose native language is not English must take the TOEFL (Test of English as a Foreign Language) and submit the results of this test with the application for admission. A student must present a minimum TOEFL score of 550 to be considered for admission. International students who have been admitted to graduate study with TOEFL scores of 550 or higher will be considered to have met the Graduate School's English language requirement. Information about the TOEFL can be



obtained by writing to the Educational Testing Service, Box 899, Princeton, NJ 08541. Like other applicants, international students must submit Graduate Record Examination scores. International students are admitted only as degree students unless a sponsoring agency requests a different classification. Such students must also fulfill the Graduate School English language proficiency requirement.

**Undergraduate Students** — A student of The Pennsylvania State University who is within 3 credits of completing the baccalaureate degree may be provisionally admitted to the Graduate School. This limit may be increased to 8 credits in the case of a student with an average of at least B (a grade-point average of 3.00). Any senior with a 3.50 grade-point average may be admitted to 500-level courses with the consent of the instructor; other seniors with a B average or better may be admitted to graduate courses with the consent of the instructor, the student's academic adviser, and the associate dean of the Office of Graduate Student Programs.

In certain cases undergraduate students may subsequently apply credits they have earned in 400- and 500-series courses toward an advanced degree at The Pennsylvania State University. Upon admission to the Graduate School, and with the approval of the major field, a maximum of 6 credits *relevant* to the graduate program of study which were not used to satisfy undergraduate requirements may be applied toward an advanced degree. The time limitation on the completion of a master's degree program applies to these as well as to other credits.

**Postdoctoral Fellows, Scholars, and Guests of the University** — Individuals holding the highest degree in their field from The Pennsylvania State University or other accredited colleges and universities are invited to apply to the dean of the Graduate School for guest privileges for purposes of noncredit study. Guests may attend seminars and courses with the privileges of faculty members and, if space and facilities are available, carry on research. Individuals with support from an outside agency are commonly given the title of postdoctoral scholar or postdoctoral fellow. Individuals may also be appointed to temporary positions in all University ranks. All guests are expected to affiliate formally or informally with one of the departments, institutes, or other subdivisions of the University engaged in scholarly pursuits.

It is the policy of the Graduate School not to permit applicants to work for a second doctoral degree.

**Student Pennsylvania Resident Status** — When it appears that an applicant for admission is not domiciled in Pennsylvania, it is assumed that the applicant is a non-Pennsylvanian. If a student who is thus admitted believes that the circumstances do not justify classification as a non-Pennsylvanian, a written petition for reclassification may be filed with the financial officer of the Graduate School, 316 Kern Graduate Building, University Park, PA 16802. Capitol Campus students may petition the Capitol Campus financial officer.

A copy of the *Policy for Determination of Eligibility for Reclassification as a Pennsylvania Resident for Tuition Purposes* can be obtained in the office of the financial officer mentioned above. Under the rules of this document, when a written petition for reclassification is made, the petitioner is required to present proof of bona fide domicile within the Commonwealth or such other evidence as is pertinent to a complete review of the student's classification. Upon review, a decision by the highest designated authority at the University shall constitute an exhaustion of administrative remedies.

Any reclassification resulting from a student's challenge shall be effective for tuition purposes as of the date such challenge was filed. A student who changes domicile from Pennsylvania to another state must promptly give written notice to the University.

## TRANSFER CREDIT

Subject to the limitations given, a maximum of 10 credits of high-quality graduate work done at another institution may be applied toward the requirements for the master's degree. However, credits earned to complete a previous master's degree may not be applied to a second master's degree program at The Pennsylvania State University.

The student should distinguish carefully between the transferability of credit and its applicability in a particular degree program. Approval to apply any transferred credits toward a degree program must be granted by the student's academic adviser, and the adviser must notify the Graduate School director of admissions, in writing, when such approval is granted. Transferred academic work must have been completed within five years prior to the date of admission to the Graduate School of The Pennsylvania State University, must be of at least B quality, and must appear on a graduate transcript. Credit earned externally in postbaccalaureate professional degree programs (law, medicine, etc.) is not transferable.

## GENERAL INFORMATION

Pass-fail grades are not transferable to an advanced degree program unless the "Pass" can be substantiated by the former institution as having at least B quality.

Forms for transfer of credit may be obtained from the Office of Graduate Admissions, 201 Kern Graduate Building.

## EXAMINATIONS

Examinations to establish credit for work done in absentia or without formal class work may be used to remove undergraduate deficiencies, but *not* to earn credits toward an advanced degree. Arrangements are made by the student directly with the major department head or program chairman.

Graduate Record Examinations are designed to test information and abilities in basic fields of knowledge. Provisions are made on the campus for administering these examinations at scheduled times and upon request of students or department program chairmen. Informational materials may be obtained at the Graduate School Information Center on the first floor of Kern Graduate Building.

## CLASSIFICATION OF STUDENTS

A graduate student may be admitted either as a degree student or as a special nondegree student, depending upon the student's objectives. After admission to one of these categories, any change to the other must be arranged through the Office of Graduate Student Programs.

**Degree Students** — A degree student is one who plans to become a candidate for an advanced degree at The Pennsylvania State University and who has been formally admitted for advanced studies in a particular program. The program of study is developed under the guidance of an adviser appointed by the head of the student's major program. A degree student who has passed a candidacy examination is classified as a doctoral candidate.

**Provisional Admissions** — Provisional admission is a temporary classification in which an applicant may remain for a period no longer than the one semester following admission or the time it takes to accrue 15 credits, whichever comes first. If the deficiencies which caused the provisional admission are not corrected by this time, the student will be dropped from the program.

**Special Nondegree Students** — An applicant who meets all requirements for admission to the Graduate School, but who does not wish to work for an advanced degree at this institution, may arrange for a program of work as a special nondegree student. This classification includes students who plan to transfer credits to another institution, casual students, and those who plan special programs of study not connected with a specific department and not leading to an advanced degree. The number of special nondegree students who can be admitted directly by the Graduate School is limited, and it is increasingly difficult to provide for them because of the limitation of resources. Preference is given to students in degree programs.

Special nondegree students who are applying for admission to the University Park Campus *must* submit two transcripts from each institution attended. Transcripts should be sent to the Office of Graduate Admissions, 201 Kern Graduate Building, The Pennsylvania State University, University Park, PA 16802. Applications and credentials must be received at least one month prior to the anticipated semester of enrollment. A maximum of 15 credits earned as a special nondegree student may be applied to a degree program.

**Certificate Students** — A certificate student is one who is engaged in a program of study leading to a certificate or equivalent recognition of accomplishment rather than a graduate degree program at The Pennsylvania State University. Certificate students have the same University privileges and responsibilities as graduate degree students.

**Undergraduate Students** — Such a student is not a graduate student since a baccalaureate degree has not been earned. The student may not register for graduate courses or research (500 and 600 series) without permission from the Office of Graduate Student Programs. A student having attained junior standing in college may register for 400-level courses and is admitted through undergraduate admissions.



## PROCEDURES AND REGULATIONS FOR STUDENTS ENROLLED IN THE GRADUATE SCHOOL

A student is expected to assume full responsibility for knowing the regulations and pertinent procedures of the Graduate School as set forth in the *Graduate Degree Programs* bulletin and in the *Thesis Information Bulletin*, and for meeting the standards and requirements expressed by these regulations. Copies of the Graduate Bulletin are available from the Graduate Commons Information Desk, 113 Kern Graduate Building; the *Thesis Information Bulletin* can be obtained from the Office of Theses and Publications, 320 Kern Graduate Building. Graduate students are encouraged to contact the Office of Graduate Student Programs, 211 Kern Graduate Building (Tel. 865-1834), for guidance if they have any questions, uncertainties, or difficulties concerning any procedure or regulation of the Graduate School or any procedure or regulation of the University as it may affect them.

### PROGRAMS

**Major Program** — A student's major program is the field of primary interest and the one in which the greater portion of graduate work is taken. Programs are designed to prepare students to assume positions of informed and responsible authority in their fields and to contribute creatively to them. They promote not only specialization, but also breadth of scholarship, the ability to study and think independently, and familiarity with the principal techniques and important literature in the field. The research undertaken by the candidate should deal with a problem which represents a significant contribution to knowledge.

**Special Interdisciplinary Majors** — In addition to the graduate major programs listed in this bulletin on pages 6 and 7, special interdisciplinary majors involving two or more departments within a single college, or intercollege majors involving two or more colleges, may be arranged with the approval of the dean of the Graduate School. These programs are offered under the supervision of appropriate interdepartmental or intercollege committees.

In general, departments of the University are identified with specific major programs. Thus, aerospace engineering is a major program of study which is offered under the supervision of the Department of Aerospace Engineering. On the other hand, acoustics and genetics are major programs for which there are no corresponding departments. In such cases, a committee of the Graduate School is responsible for administering the program. In some cases a single department offers work in more than one program. For instance, the Department of Material Sciences offers work in ceramic science, fuel science, metallurgy, and mineral processing.

Applicants for admission are encouraged to consult the person whose name is listed under the major program heading in the GRADUATE PROGRAMS, FACULTY, AND COURSES section of the Graduate Bulletin.

### ADVANCED DEGREES OFFERED

The degrees of Doctor of Philosophy and Doctor of Education are conferred by the University. Both require high attainment and productive scholarship, but the Ph.D. places a strong emphasis on research, whereas the D.Ed. emphasizes professional competence in some field of education.

The Master of Arts and the Master of Science degrees are academic in nature, the programs placing strong emphasis on basic knowledge and research. The professional master's degrees conferred are the Master of Administration, Master of Agriculture, Master of Architecture, Master of Business Administration, Master of Education, Master of Engineering, Master of Environmental Pollution Control, Master of Fine Arts, Master of Forest Resources, Master of Music, Master of Psychosocial Science, Master of Public Administration, and Master of Regional Planning.

Candidates for the M.Ad., M.Ed. with a major in Health Education, M.Ed. with a major in Teaching and Curriculum, M.E.P.C., M.P.A., M.Ps.Sc., or M.R.P. degree may meet all the requirements for these degrees at the Capitol Campus of The Pennsylvania State University. Programs leading to the degree of Master of Engineering with a major in Engineering Science have been approved for the Behrend College, the King of Prussia Center for Graduate Studies, and the Capitol Campus. The M.P.A. and M.R.P. programs also are available at the King of Prussia Center. Designation of location of program completion will be noted on the student's transcript.

## REGISTRATION

The responsibility for being properly registered rests with the student. The student is expected to register each semester for either course work or research toward the thesis, whether it be on or off campus. In the case of research, the number of credits shall be determined by the amount of time required for the investigation, 1 credit representing the equivalent of one week of full-time work. In the later stages of the program the situation will determine the requirements for the student's registration. (See below, Registration Near the Completion of a Program.)

**Advisers** — To assist the student in planning a program, the head of the major department or program chairman will designate a member of the faculty to serve as adviser. It is the student's responsibility to secure the name of an adviser from the department head and to seek a conference before registration.

**Time of Registration** — Registration days are indicated in the calendar at the beginning of this bulletin.

A student is expected to complete registration during the officially designated period and to attend the first meeting of all classes. If this is impossible because of some emergency or unusual circumstance, the student may be granted permission by the instructor to miss a few class meetings, it being understood that work missed will be made up subsequently. Under these conditions permission may be granted through the Office of Graduate Student Programs for the student to register late. In general, a student who receives permission to register late will be required to reduce the course load in proportion to the length of the absence.

A student who fails to complete the process of registration within the officially designated registration period will be liable for the late registration charge, regardless of when the student begins attending classes.

**Continuity of Registration** — A student who registers at University Park without interruption for each of the two semesters in the August-to-June interval, or for summer sessions only is considered to have maintained a normal continuity of registration.

Anyone who has interrupted such a normal sequence and now plans to register for work at the University Park Campus is required to apply to the Office of Graduate Student Programs, 211 Kern Graduate Building, at least one month before the time of registration, for permission to resume study.

The policy may be summarized for any specific semester or session as follows:

*Summer Session* — Application required unless the student was registered at University Park for the preceding spring semester or the preceding summer session.

*Fall Semester* — Application required unless the student was registered at University Park for the preceding summer session or the preceding spring semester.

*Spring Semester* — Application required unless the student was registered at University Park for the preceding fall semester.

**Procedure** — For each registration the student, in consultation with the adviser, prepares a schedule of courses and research designed to fit individual needs. The credit load will be reviewed at the time of registration. The registration process is completed in the manner specified for all students at the University.

Under certain conditions credit may be earned for work done away from the campus. A student contemplating such work should inquire at the Office of Graduate Student Programs about the procedures and conditions. The student must assume responsibility for the registration process, but the operation can be handled by mail. Registration must be completed before the close of central registration at University Park.

A student must register for courses audited as well as for those taken for credit.

## GRADUATE CREDITS

It is important that the student understand that in the Graduate School the word "credit" has no meaning other than as a unit of time — time spent in residence and in off-campus graduate work. One credit stands for the equivalent of approximately one week of full-time graduate work, and 15 credits for a semester's work.

Typically, a candidate for an advanced degree is required to earn a certain minimum number of credits at The Pennsylvania State University. Consequently, there is a limit to the number of credits which may be earned at another approved institution or through continuing education to meet the



minimum requirements of the degree. Moreover, the department or committee in charge of a major program may require a student to do more of the work at the University than specified by the limitations set by the Graduate Faculty. The normal credit load of a full-time graduate student is 12 to 15 credits per semester or the equivalent (see **ACADEMIC CREDIT AND EMPLOYMENT**, page 40).

Graduate courses carry numbers from 500 to 599. Advanced undergraduate courses numbered between 400 and 499 may be used to meet some graduate degree requirements when taken by graduate students.

**Course Numbering System** — Courses in the series 1-399 are not listed in this bulletin because they are strictly undergraduate and yield no graduate credit. A graduate student may register for or audit these courses in order to make up deficiencies or to fill in gaps in previous education but not to meet requirements for an advanced degree.

Courses in the series 400-499 are for upperclass students with at least junior standing and for graduate students. Only a limited number of credits earned in these courses may be counted toward the requirements for an advanced degree. Detailed regulations concerning the restrictions are given on pages 49-55 under the specific requirements for the various master's degrees.

Courses in the series 500-599 are restricted to students registered in the Graduate School, seniors with an average of at least 3.50, and other students who have been granted permission to enroll through the Office of Graduate Student Programs.

The numbers 600 (on campus) and 610 (off campus) are available for credit in thesis research in all graduate major programs. The numbers 601 and 611 do not denote courses but are used for noncredit special registration for thesis preparation by a Ph.D. candidate. Registration under these numbers will maintain status as a student during the interval which begins at the time the student passes the comprehensive examination and meets the two-semester residence requirement and ends at the time the doctoral committee accepts the thesis. The student will register for 601 if engaged full time in the preparation of a thesis, or will register for 611 if engaged only part time in thesis preparation. Candidates for the Ph.D. degree do not receive grades for noncredit registrations (601 and 611).

**Continuing Education Credits** — A large number of courses carrying credit are given throughout the Commonwealth of Pennsylvania through continuing education. All 400-series courses so offered *may* be used to meet graduate degree requirements when taken by students who have been admitted to the Graduate School. The graduate adviser's signature is required on the official registration form, which the student submits at the designated place of registration for the course.

There is no limit to the number of credits which a student may earn in continuing education, but not more than 10 credits in 400-level courses so earned may be applied toward the minimum requirements for an advanced degree.

**Schedule of Courses** — A complete list of the courses which will be offered in any specific semester is given in the *Schedule of Classes*, which is available at nominal cost from the Scheduling Office approximately four months before the beginning of the semester. It gives the number of credits being offered in each course, the hours at which the class will meet, the location of the class, and in some cases the instructor's name.

**Visiting and Auditing Classes** — A graduate student registered for a given semester who wishes to attend classes without receiving credit may secure permission either to visit or to audit courses during that semester.

As a visitor, a student may attend classes with the approval of the instructor but may not claim the usual privileges of class membership, such as participating in discussion, doing practicum work, or taking examinations. Registration is not required for the privilege of visiting, and no record appears on the student's transcript.

As an auditor, a student may participate in class discussion, do practicum work, take examinations, and generally enjoy the privileges of a class member. Registration procedures and fee payment are the same as for taking the course for credit. No credit is given, either on completion of the course or at a later time; however, the number of credits assigned to the course appears on the grade report and on the student's transcript. Thus, when a student receives an audit grade, the number of credits audited is shown. The symbol Au shall be used if attendance has been regular, the symbol W if attendance has been unsatisfactory.

A graduate assistant or fellow, who is required to register for a certain minimum number of credits, is not permitted to count audited course credits toward the minimum credits needed. The 1G and 2G language courses are an exception. The student may register for credit or audit beyond the required minimum but may not exceed the normal maximum without special permission.

## GENERAL INFORMATION

In general, students are encouraged to visit classes rather than to register for a course as auditors. However, visiting is not permitted in German 1G and 2G.

In the 1G and 2G courses offered by the language departments, no distinction is made between registering for credit and for audit in considering loads.

**Common Courses** — The following courses for which students may register have been set up for common use by major programs, with University Senate approval, to encourage innovation and provide flexibility in designing graduate programs:

590. COLLOQUIUM (1-3) Continuing seminars which consist of a series of individual lectures by faculty, students, or outside speakers.

596. INDIVIDUAL STUDIES (1-9) Creative projects, including nonthesis research, which are supervised on an individual basis and which fall outside the scope of formal courses. A specific title may be used in each instance and will be entered on the student's transcript. Multiple offerings may be accommodated by the use of suffixes a, b, etc.

597. SPECIAL TOPICS (1-9) Formal courses given on a topical or special interest subject which may be offered infrequently; several different topics may be taught in one year or semester. A specific title may be used in each instance and will be entered on the student's transcript. Multiple offerings may be accommodated by the use of suffixes a, b, etc.

600, 610. THESIS RESEARCH — In registering for thesis research a student uses the appropriate number (600, 610) preceded by the abbreviation designating the major field. The numbers 600 (on campus) and 610 (off campus) are available for credit in thesis research in all graduate major programs. The bursar assesses charges for these courses at the current rate of tuition, according to the student's status at the time of registration.

601, 611. THESIS PREPARATION — The numbers 601 and 611 are available to Ph.D. degree candidates and are used for special noncredit registration for thesis preparation work. Such candidates must have passed the comprehensive examination and must have met the two-semester residence requirement. A candidate registered for SUBJ. 601 is classified as a full-time student, while one registered for SUBJ. 611 is classified as a part-time student.

The numbers 600, 601, 610, and 611 may not always appear in the *Schedule of Classes* for each semester.

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6) May be offered by any graduate program in a department which also offers undergraduate courses. A graduate program with no counterpart undergraduate program may offer SUBJ. 602 when cooperative arrangements are made with an administrative unit which does not offer graduate degrees but which uses graduate assistants in its teaching. SUBJ. 602 may be offered in any semester and is subject to the following restrictions:

1. SUBJ. 602 shall not be counted in fulfilling any specific credit requirement for an advanced degree.
2. SUBJ. 602 shall be graded (A, B, C, D, F).
3. SUBJ. 602 shall not be used in calculating grade-point averages.
4. SUBJ. 602 shall be offered only in those graduate programs wishing to provide opportunity for supervised and graded teaching experience. Enrollment shall be restricted to students for whom the major program is prepared to provide such experience.
5. SUBJ. 602 may, but need not, be counted as a part of the normal credit load for graduate assistants.

## ACADEMIC CREDIT AND EMPLOYMENT

To provide flexibility in arranging credit loads for graduate assistants and full-time University staff members, a procedure has been set up whereby the normal credit limits may be changed by permission of the person to whom the student or staff member is responsible for University employment or assistantship assignment. Maintenance of the established credit loads and responsibility for the consequences of a graduate student's change of course load rests with the student and adviser. The course load is a factor in determining whether a graduate student is classified as a full-time or part-time student; has met residence requirements; and is eligible to hold a fellowship, scholarship, assistantship, or departmental or program appointment. Students holding fellowships, traineeships, or other awards based on academic excellence are commonly required to carry 12 or more credits each semester.

The University takes the position that the facilities of the Graduate School should be made avail-



able first to students who can profit from their graduate school experience to the maximum extent. More than doing what is required in courses or in research, the graduate experience is one of living in a scholarly atmosphere and seriously engaging in scholarly pursuits. It means profiting from hearing visiting scholars and artists and from engaging in discussions, both formal and informal, with faculty members and fellow students. It is an involvement and participation in student affairs, University and Graduate School governance, committee assignments, and personal contribution of effort to the welfare and betterment of the University graduate community. It should mean leisure time for reflection and for exploring fields related to, although not directly a part of, one's specialty. Students who propose schedules of few credits not requiring serious effort, or those who wish to carry overloads of such proportion as to handicap them seriously in achieving maximum quality, find it difficult and often impossible to experience the satisfaction of a well-rounded scholarly attainment.

A graduate student should achieve a balance between academic credit load, employment, and appointment responsibilities which results in classification as a full-time graduate student with all the privileges and responsibilities intrinsic to this classification. The student's full-time classification is certified by the department head or program chairman and is sent to the Office of Graduate Student Programs.\*

**Full-Time Academic Status** — A student who in any semester is registered for 12 or more credits *or* who holds a quarter-time assistantship and schedules 11 credits *or* who has a half-time assistantship and schedules 8 credits *or* who holds a three-quarter-time assistantship and schedules 6 credits *or* who is enrolled in SUBJ. 601 is considered to be engaged in full-time academic work for that semester.

**Part-Time Academic Status** — A student who in any semester is registered for fewer than 12 credits and does not hold a half-time or quarter-time assistantship is considered to be engaged in part-time academic work for that semester.

**Full-Time Employment Off Campus** — A candidate for the Ph.D. degree may not count the work of any semester toward the residence requirement for this degree while engaged in full-time employment off campus.

**Benefits and Privileges** — A student registered for 12 or more credits of course work *or* for noncredit SUBJ. 601 *or* who holds a half-time assistantship and is carrying at least 8 credits is entitled to the *nonacademic* student benefits and privileges of a full-time student.

**Staff Employee Credit Status\*** — A full-time staff employee of the University may schedule 6 credits per semester or 4 credits per summer session (up to 16 credits per academic year), either for credit or audit.

No member of the faculty in one of the professorial ranks in the University may receive the master's degree or the doctoral degree from the University.

For University staff employees desiring to take graduate degree work, admission to the Graduate School is a first essential.

**Employment** — Many students depend upon part-time employment to help meet their expenses. A student who is thus employed, whether on campus or off campus, must recognize the time demands of a work schedule in planning an academic program. A student holding a fellowship or scholarship may not accept employment of any kind for service beyond that specifically permitted by the appointment. Graduate assistants may accept concurrent employment outside the University only after obtaining permission from the head of the department providing the assistantship and from the person in charge of the assistant's graduate program. A graduate assistant may not hold a concurrent appointment with the University other than a Fellowship Supplement.

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\*Full-time University employees and three-quarter-time graduate assistants may meet Ph.D. degree residence requirements by registering for the full number of credits allowable (6 credits per semester or 4 credits per summer session for full-time University employees, 6-8 credits for three-quarter-time assistants) and by obtaining certification from the department head as being principally engaged in activities relating to their academic programs.

## GENERAL INFORMATION

### GRADING SYSTEM

A grade is given solely on the basis of the instructor's judgment as to the student's scholarly attainment.

The following grading system is in effect: Any one of five quality grades (A,B,C,D,F) may be given a graduate student for course work or for thesis research. The grade-point equivalents are 4.00, 3.00, 2.00, 1.00, 0, respectively.

At the 400, 500, and 600 levels, grades of A, B, and C denote graduate credit, whereas D and F are failing grades for graduate students, D being the normal failing grade. A grade of F indicates doubt in the judgment of the instructor of the student's potential for further graduate study.

A minimum grade-point average of 3.00 for work done at the University is required for graduation.

In addition to the quality grades listed above, two symbols, Def. (deferred) and R, may appear on a student's transcript. If work is incomplete at the end of a semester for a reason beyond the student's control, or if very little work remains to be done, the instructor may report Def. in place of a grade, which will appear temporarily on the student's record. The deferral must be removed within nine weeks of the beginning of the succeeding semester, unless a special extension is granted by the associate dean of the Office of Graduate Student Programs. If the work is completed within the specified period of deferral, and the instructor does not report a passing grade, the graduate recorder automatically records a failing grade after duly notifying the department head or program chairman to that effect. No student may be approved for a degree while a grade deferral for a required course remains on the record. Deferred grade cards may be obtained from the graduate recorder, 112 Shields Building.

In the case of thesis work, either in progress or completed, and certain courses approved by the University Senate, the instructor may report the symbol R in place of a grade. This symbol indicates that the student has devoted an adequate amount of time to the work scheduled but gives no indication of its quality. When reported for thesis work, this symbol will not influence the grade-point average and remains on the student's transcript permanently if not converted to a quality grade (A,B,C,D, or F) within one semester of its recording. Quality grades reported for a given semester for thesis work will be included in the cumulative grade-point average. Quality grades reported for research will not apply to R's given for earlier registrations and will not denote the quality of an entire series of R's. It is expected that an R grade for a course will be changed to a quality grade when the work for that course has been completed. Ordinarily, a quality grade will be reported no later than the end of the following semester.

### CHANGE OF DEGREE OR PROGRAM

A graduate student who has been admitted for work in one major program but wishes to transfer to another should submit a request to the Office of Graduate Student Programs of the Graduate School. The student's credentials will be reviewed and the proposed new major department head or committee chairman consulted. If the change is approved but the student is inadequately prepared for the new major, the student may be required to make up certain undergraduate deficiencies.

A graduate student admitted for either an academic degree (M.A., M.S., or Ph.D.) or a professional degree (M.Ad., M.Agr., M.Arch., M.B.A., M.E.P.C., M.Ed., M.Eng., M.F.A., M.F.R., M.Mus., M.P.A., M.Ps.Sc., M.R.P., or D.Ed.) who wishes to change from one type of degree program to another must apply to the Office of Graduate Student Programs for the transfer. Similarly, a student who has earned a master's degree but wishes to earn a different type of doctoral degree must apply for a formal transfer. A student may be required to make up certain deficiencies if inadequately prepared for the new program.

**Registration Near the Completion of a Program** — A candidate for the Ph.D. degree is required to register continuously for each semester from the time the comprehensive examination is passed and the two-semester residence requirement is met until the thesis is accepted by the doctoral committee, regardless of whether work is being done on the thesis during this interval.

D.Ed. degree candidates and master's students may be required to register for a normal credit load because of their appointment status. A student, other than the Ph.D. degree candidate, who has met the minimum requirements for a degree and is now completing research and thesis writing off campus is not required to register, even if visits are made to the campus several times each semester to see an adviser, unless required to do so within the program.

A student, other than one following the Ph.D. requirement, is not required to register for the final semester in order to graduate or in order to make minor revision to the thesis and/or to take a final examination for the degree, unless required to do so by the program.



**Thesis Research** — In registering for thesis research a student uses the appropriate number (600, 610) preceded by the abbreviation designating the major field. The numbers 600 (on campus) and 610 (off campus) are available for credit in thesis research in all graduate major programs. The bursar assesses charges for these courses at the current rate of tuition, according to the student's status at the time of registration.

**Thesis Preparation** — The numbers 601 and 611 are available to Ph.D. degree candidates and are used for special noncredit registration for thesis preparation work. Such candidates must have passed the comprehensive examination and must have met the two-semester residence requirement. A candidate registered for SUBJ. 601 is classified as a full-time student, while one registered for SUBJ. 611 is classified as a part-time student.

The numbers 600, 601, 610, and 611 may not always appear in the *Schedule of Classes* for each semester.

## GRADUATION

It is the responsibility of the student to inform the graduate recorder of intention to graduate (by filing a diploma card) and to pay the thesis fee at the beginning of the semester or summer session in which an advanced degree is expected to be received. If the student does not graduate, the diploma card must be reactivated during the actual semester or summer session of graduation. Deadlines are given in the calendar found at the beginning of the Graduate Bulletin.

A preliminary graduation list is prepared by the graduate recorder soon after the deadline for each semester or summer session. Transcripts are prepared and checked in the offices of the Graduate School and the recorder. The records of candidates who appear to have met requirements are forwarded to major and minor department heads or program chairmen for review and recommendation. The final list of approved candidates appears in the spring or summer commencement program.

Only those transfer credits which have been accepted by the Graduate School and entered upon the student's transcript by the recorder before the graduate list deadline will be considered in evaluating a student for graduation at the end of that particular semester or summer session.

The University holds commencement exercises twice a year, at the end of the spring semester and the summer session. Degree conferral for students who have completed all degree requirements in the latter part of the calendar year also occurs in December, with the opportunity to participate in the following spring semester commencement exercises. Attendance at commencement exercises is expected, but forms for permission to receive the degree in absentia are available in the Office of Graduate Student Programs in 211 Kern Graduate Building and in the Office of Graduate Records in 112 Shields Building. The form must be completed and filed with the graduate recorder by the date specified in the graduate calendar.

All degrees conferred are tentative until final grade reports have been received and all requirements fulfilled, even though the student's name may have appeared in the commencement program. A student's transcript or diploma, or both, may be withheld until any outstanding financial obligations to the University have been paid.

## UNSATISFACTORY SCHOLARSHIP

A graduate student who fails to maintain satisfactory scholarship or to make acceptable progress in a degree program will be dropped from the University. A cumulative grade-point average below 3.00 for any semester or session or combination of semesters and/or sessions may be considered as evidence of failure to maintain satisfactory scholarship. Action may be initiated by the department or committee in charge of the graduate major or by the chairman of the student's doctoral committee.

## MOTOR VEHICLE REGULATIONS

Each graduate student who possesses, maintains, or operates a motor vehicle (including a motorcycle, motor bike, motor scooter, or any other motor-driven vehicle) while at the University is required to register such vehicle with the Student Traffic Office, 105 Boucke Building, during the registration period at the opening of classes. There is no registration charge for students who do not desire campus driving or parking privileges. Failure to register a vehicle renders a student liable for a fine of \$15 or a magistrate's citation for each offense.

A permit allowing limited driving and parking on the campus throughout the week costs \$15 per semester. A more restricted permit allowing driving and parking on the campus for evenings and weekends costs only \$5.25 per semester.

## GENERAL INFORMATION

A graduate assistant pays no fee for the privilege of driving and parking on the campus but is required to comply with student regulations concerning motor vehicles. A graduate assistant receiving any permit must present a valid driver's license and the owner's card for the vehicle. Pennsylvania registration of all motor vehicles is required if the student lives for more than thirty consecutive days of the year in Pennsylvania. A student's spouse may be required to register his or her car in Pennsylvania. A *Student Parking and Traffic Regulations* booklet is available in 105 Boucke Building.

**Bicycles** — A bicycle is defined as a two-wheeled vehicle propelled by human power. All bicycles operated on the University Park Campus or in the surrounding community must be registered once each year. Expiration date is May 31. Registration may be obtained at the Department of University Safety, 12 Grange Building, Monday through Friday between 8:00 a.m. and 5:00 p.m. Rules and regulations are available at the time of registration.

## GRADUATE DEGREE REQUIREMENTS

### DOCTORAL DEGREES

The Doctor of Philosophy, an academic degree, and the Doctor of Education, a professional degree, are conferred by the University. Recognized as different in purpose, the two programs consequently have different requirements in certain respects.

#### ADMISSION

A student who has been admitted to the Graduate School and has been accepted by the department or committee in charge of a major program in which the doctorate is offered may begin working toward a doctoral degree. However, the student has no official status as a doctoral student and no assurance of acceptance as a doctoral candidate until the candidacy examination has been passed. This examination is administered by the major department or graduate program and is given early in the student's program.

It is the policy of the Graduate School not to permit applicants to work for a second doctoral degree. The President, on recommendation of the dean of the Graduate School, will welcome, as guests, holders of earned doctoral degrees who may be visiting the University Park Campus for purposes of noncredit study. Guest privileges apply to persons holding the degree from The Pennsylvania State University or other accredited colleges and universities. Guests may attend seminars and courses and, if space and facilities are available, carry on research. There will be no charge except for laboratory expenses. Arrangements should be made in advance with the dean of the Graduate School.

#### GENERAL REQUIREMENTS

No specified number of courses completed or credits earned will assure attainment of the doctorate. The general requirements are based upon a period of residence, the writing of a satisfactory thesis, and the passing of a comprehensive and a final oral examination. A doctoral program consists of such a combination of course seminars, and individual study and research as meets the minimum requirements of the Graduate School and is approved by the doctoral committee for each individual student.

A master's degree is not a prerequisite for the doctorate in some major programs. However, the first year of graduate study leading to the Ph.D. may be substantially the same as that provided for the M.A. or M.S. degree. Similarly, the first year of the D.Ed. program may be essentially the same as that provided for the M.Ed. degree.

#### GRADE-POINT AVERAGE

A minimum grade-point average of 3.00 for work done at the University is required for admission to the comprehensive examination and for graduation.

#### TIME LIMITATION

A student is required to complete the program within seven years from the date of acceptance as a candidate.



## OFF-CAMPUS AND TRANSFER CREDITS

Subject to the approval of the adviser and the head of the major department or program chairman, a student may register for research to be done away from the University Park Campus.

A maximum of 30 credits beyond the baccalaureate at an accredited school not granting the doctorate in the student's major program may be accepted by the Graduate School in partial fulfillment of the requirement for a doctoral degree at The Pennsylvania State University. A maximum of two full academic years of work (60 credits) beyond the baccalaureate at an accredited graduate school which grants the doctorate in the candidate's major program may be accepted here to apply toward doctoral degree requirements. Advanced standing is awarded for only one master's degree. Academic work to be so transferred must meet the following criteria: (1) It must have been completed within five years prior to the date of admission to the Graduate School of The Pennsylvania State University; (2) it must appear on an official graduate transcript; (3) it must be of at least B quality; and (4) it must be deemed applicable to the student's program by the current academic adviser, approved in writing, and submitted to the Graduate School assistant director of admissions for approval and action. Credit earned externally in postbaccalaureate professional degree programs (law, medicine, etc.) is not transferable.

The following caveat should be noted. Pass-fail grades are not transferable to an advanced degree program unless the "pass" can be substantiated by the former institution as having at least B quality.

A completed master's degree may be transferred to a doctoral program with no intervening time limitation.

## ADVISERS AND DOCTORAL COMMITTEES

Following admittance to a degree program, the student should confer with the head of that major department or program concerning procedures and the appointment of an adviser. Arrangement and approval of the details of the student's semester-by-semester schedule is the function of the adviser. This person may be a member of the doctoral committee or someone else designated by the head of the major program for this specific duty.

General guidance of a doctoral candidate is the responsibility of a doctoral committee consisting of four or more members of the Graduate Faculty. One member shall be from outside the candidate's major program. (For the D.Ed. doctoral committee, this committee member must be a faculty member in the candidate's minor field or general studies area — *See MAJOR PROGRAM AND MINOR FIELD under D.Ed.* — *ADDITIONAL SPECIFIC REQUIREMENTS.*) This committee is appointed through the Office of Graduate Student Programs, upon recommendation of the head of the major program, after the student is admitted to candidacy. At the discretion of the associate dean, other members may be added to the committee. The supervisor of the candidate's thesis will usually, but not necessarily, be designated as chairman. The chairman must hold senior membership in the Graduate Faculty. An associate member may supervise the research of a doctoral candidate.

The doctoral committee is responsible for establishing the broad outline of the student's program and should review the program as soon as possible after the student's admission to candidacy. It will prepare, give, and evaluate the candidate's examinations, and supervise and approve the thesis. A favorable vote of at least two-thirds of the members of the committee is required for passing a comprehensive or a final oral examination. If a candidate fails an examination, it is the responsibility of the doctoral committee to determine whether another examination may be taken.

The committee will also notify the associate dean when the candidate is ready to have the comprehensive and the final oral examinations scheduled and will report the results of these examinations to the Office of Graduate Student Programs.

## COMMUNICATION AND FOREIGN LANGUAGE COMPETENCE

A candidate for the degree of Doctor of Philosophy is required to demonstrate high-level competence in the use of the English language, including reading, writing, listening, and speaking. Proficiency is expected at the time of admission to the Graduate School or must be achieved before admission to candidacy.

In addition to demonstrating competence in English, each candidate for the Ph.D. must meet any communication and foreign language requirements which have been established within the major program. The candidate should ascertain specific language requirements by contacting the professor in charge of the program, whose name appears with the program description under *GRADUATE PROGRAMS, FACULTY, AND COURSES*.

If a candidate is to be examined for knowledge of a foreign language other than French or Spanish, the intention to take the examination must be reported to the secretary of the language department by

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the end of the first week of classes for the semester during which the examination is to be taken. This date is one week prior to the examination date. This written examination will be administered on dates announced for each semester by the Office of Graduate Student Programs, 211 Kern Graduate Building.

The Pennsylvania State University has been named by the Educational Testing Service as a testing center for the administration of the written tests for students to be examined in French or Spanish. Students wishing to make application to take these tests should, at their earliest convenience, check with the Office of Examination Services, 207 Mitchell Building, University Park, PA 16802. A test fee of \$12 is payable at the time of application. Times and places of tests will be given when the test application is filed.

Candidates for the Doctor of Education degree may be required to demonstrate competence in foreign languages.

## CANDIDACY EXAMINATION

The candidacy examination is administered by the Graduate Faculty in the graduate major program and should be taken early in the student's program. The nature of the examination varies with the program and may be the master's examination if so allowed. The decision to admit or not to admit a student to candidacy must be made by the Graduate Faculty or a designated committee of Graduate Faculty. For the Ph.D. student the examination may be given after at least 18 credits have been earned in graduate courses beyond the baccalaureate. The examination must be taken within two semesters after having earned 24 credits.

For the D.Ed. student, the examination should be given when the student has earned a total of approximately 30 credits, including the master's program and work done elsewhere. A student transferring from another graduate school with 30 or more transfer credits must take the candidacy examination prior to earning more than 15 credits here.

## COMPREHENSIVE EXAMINATION

When a candidate for the Ph.D. or D.Ed. degree has substantially completed the course work, a comprehensive examination covering the major program and minor field of study is required.

A candidate for the Ph.D. must have satisfied the communication and foreign language requirement before taking the examination.

All candidates are required to have a minimum grade-point average of 3.00 for work done at the University at the time the comprehensive examination is given.

The examination is officially scheduled and announced by the associate dean for graduate student programs upon recommendation of the doctoral committee. Two weeks' notice is required by the Graduate School for scheduling this examination. It is given and evaluated by the doctoral committee and may be *either written or oral, or both*. A favorable vote of at least two-thirds of the members of the committee is required for passing. In case of failure, it is the responsibility of the doctoral committee to determine whether the candidate may take another examination. The results are reported to the Office of Graduate Student Programs and will be entered on the candidate's official record.

When a period of more than five years has elapsed between the passing of the comprehensive examination and the completion of the program, the student is required to pass a second comprehensive examination before the final oral examination will be scheduled.

## FINAL ORAL EXAMINATION

The doctoral candidate who has satisfied all other requirements for the degree will be scheduled by the associate dean for graduate student programs, on the recommendation of the doctoral committee, to take a final examination. Two weeks' notice is required by the Graduate School for scheduling this examination. Normally the final oral examination may not be scheduled until at least three months have elapsed after the comprehensive examination was passed, although the associate dean may grant a waiver in the case of an outstanding student. The deadline for holding the examination is seven weeks before commencement or fall semester degree conferral. It is the responsibility of the doctoral candidate to provide a copy of the thesis to each member of the doctoral committee at least one week before the date of the scheduled examination.

The final examination is oral, open to the public, and related in large part to the thesis; but it may cover the candidate's whole program of study without regard to courses that have been taken either here or elsewhere.

A favorable vote of at least two-thirds of the members of the committee is required for passing. The results of the examination are reported to the Office of Graduate Student Programs and will be



entered upon the candidate's official record. If a candidate fails, it is the responsibility of the doctoral committee to determine whether another examination may be taken.

## Ph.D. — ADDITIONAL SPECIFIC REQUIREMENTS

The degree of Doctor of Philosophy is conferred in recognition of high attainment and productive scholarship in some special field of learning as evidenced by (1) the satisfactory completion of a prescribed period of study and investigation; (2) the preparation of a thesis involving independent research; and (3) the successful passing of examinations covering both the special subject and the general field of learning of which this subject forms a part.

### RESIDENCE REQUIREMENTS

There is no required minimum of credits or semesters of study, but over some twelve-month period during the interval between admission to candidacy and completion of the Ph.D. program the candidate must spend at least two semesters (which may include the semester in which the candidacy examination is taken) as a registered full-time student engaged in academic work on the University Park Campus or at The Milton S. Hershey Medical Center. Full-time University employees must be certified by the department as devoting half time or more to graduate studies and/or thesis research to meet the degree requirements (see ACADEMIC CREDIT AND EMPLOYMENT, page 40).

### CONTINUOUS REGISTRATION

After a student has passed the comprehensive examination *and* met the two-semester residence requirement, no further registration for credit will be required by the Graduate School. However, status as a student must be maintained by registering continuously (for each semester, beginning with the first semester after both of the requirements mentioned above have been met) until the thesis is accepted by the doctoral committee. This registration may be for (1) noncredit 601 or 611 only, with payment of the special thesis preparation fee; (2) noncredit 601 or 611, with payment of the special thesis preparation fee plus course registration at the regular per credit fee; or (3) full-time course credits, with payment of the regular tuition fee. Grades are not given for noncredit 601 or 611. Failure to maintain registration will result in termination of student status.

### MINOR FIELD

A Ph.D. candidate is not required by the Graduate Faculty to have a minor field of study. However, a department or a committee in charge of a major field may require a candidate to offer work in a minor field, or a student may elect such a program with the permission of the doctoral committee.

A minor consists of no fewer than 15 credits, including those applied toward the master's degree, of integrated or articulated work in one field related to, but different from, that of the major. A minor program must meet the approval of the departments or committees responsible for both the major program and the minor field.

### THESIS

The ability to do independent research and competence in scholarly exposition must be demonstrated by the preparation of a thesis on some topic related to the major subject. It should represent a significant contribution to knowledge, be presented in a scholarly manner, reveal an ability on the part of the candidate to do independent research of high quality, and indicate considerable experience in using a variety of research techniques. The contents and conclusions of the thesis must be defended at the time of the final oral examination.

The completed thesis must be submitted to the Office of Theses and Publications by the announced submission deadline for the semester or summer session.

A *Thesis Information Bulletin*, which gives details concerning format, paper, typing, and other requirements, may be obtained at the Graduate School Office of Theses and Publications, 320 Kern Graduate Building. Following editorial review of the thesis by this office, it is expected that the student will submit a copy of the thesis, incorporating format corrections, to the office of the department or program head.

## **D.Ed. — ADDITIONAL SPECIFIC REQUIREMENTS**

Programs leading to the degree of Doctor of Education are not limited to specific fields of education but, with the consent of the department or committee in charge and concurrence by the dean of the College of Education, may also be offered in any other field appropriate to the preparation of professional educators which has been approved for the doctorate.

The degree is conferred in recognition of advanced preparation of a high order for work in the profession of education as evidenced by (1) satisfactory completion of a prescribed period of study; (2) ability to apply scientific principles to practitioner problems in a variety of education endeavors; (3) preparation of a thesis demonstrating ability to undertake an educational problem with originality and independent thought; and (4) successful performance on major and minor examinations, showing a satisfactory grasp of the field of specialization and its relation to allied education areas.

### **RESIDENCE REQUIREMENTS**

A minimum of six semesters of full-time graduate study and research (15 credits per semester), or their equivalent in credits (90 credits), of which at least 30 credits must be earned in residence, is required for the D.Ed. degree. The D.Ed. candidate may meet the requirements by attending summer sessions unless the major department requires a period of registration at University Park. A candidate may register for a maximum of 30 credits of research in absentia, but none of these may count toward the minimum of 30 credits which must be earned at the University Park Campus. It is expected that students will register for a minimum of 15 credits of thesis research. The maximum credit load permitted a student who is employed full time is 6 credits per semester.

### **MAJOR PROGRAM AND MINOR FIELD**

The program of study includes a major and either a minor or a group of general studies. A majority of the courses offered in fulfillment of the requirements must be in the major program of study.

A candidate choosing a major outside the field of education (such as history) shall have a minor consisting of no fewer than 15 credits in education, including those applied toward the master's degree, as recommended to the dean of the Graduate School early in the major program with the approval of a faculty adviser designated by the dean of the College of Education.

A candidate choosing a major in one of the approved programs in education must also choose either a minor or a group of general studies with the approval of the major program chairman. In this case a minor consists of no fewer than 15 credits, including those applied toward the master's degree, in one field outside those of education. An acceptable general studies group consists of no fewer than 15 credits, including those applied toward the master's degree, in fields outside those of education considered by the major program committee to have significance and value for the candidate.

### **COMPREHENSIVE EXAMINATION**

In addition to demonstrating a high level of competence in the subject matter in the major program and minor field, each candidate must show, by a comprehensive examination, an understanding of current theories of education and the ability to apply the techniques and findings of educational research so far as they bear upon the teaching of the subject matter. The candidate must also be able to understand and contribute to the technical and professional literature in the field, and to criticize learned procedures in the light of historical trends and practices in this and other countries. Command of the tools for a thorough study of the problems of education is necessary and must include competence in the use of statistical methods. For certain students the requirements may include a reading knowledge of one or more foreign languages.

All candidates are required to have a minimum grade-point average of 3.00 for academic work done at the University at the time the comprehensive examination is given.

### **THESIS**

Evidence of a high degree of scholarship, competence in scholarly exposition, and ability to select, organize, and apply knowledge must be presented by the candidate in the form of a written thesis. The candidate must demonstrate a capacity for independent thought, as well as ability and originality in the application of educational principles or in the development of a new generalization under scientific controls. A thesis may be based upon a product or project of a professional nature, provided scholarly research is involved. For example, it may be based upon the solution of a professional problem concerned with the development of a curriculum, or a product of creative effort related to educa-



tion. However, in order to be acceptable as a thesis, the professional project must be accompanied by a written discourse demonstrating the nature of the research and including such theories, experiments, and other rational processes as were used in effecting the final result. The topic and outline of the proposed thesis must have the approval of the doctoral committee.

The completed thesis must be submitted to the Office of Theses and Publications by the announced submission deadline for the semester or summer session.

A *Thesis Information Bulletin*, which gives details concerning format, paper, typing, and other requirements, may be obtained at the Graduate School Office of Theses and Publications, 320 Kern Graduate Building. Following editorial review of the thesis by this office, it is expected that the student will submit a copy of the thesis, incorporating format corrections, to the office of the department or program head.

## MASTER'S DEGREES

The Graduate School recognizes a difference in purpose, which is reflected in the requirements, for two types of advanced degrees, academic and professional. Of the fifteen master's degrees conferred, the Master of Arts and Master of Science are academic in nature. The professional degrees conferred are Master of Administration, Master of Agriculture, Master of Architecture, Master of Business Administration, Master of Education, Master of Engineering, Master of Environmental Pollution Control, Master of Fine Arts, Master of Forest Resources, Master of Music, Master of Psychosocial Science, Master of Public Administration, and Master of Regional Planning.

A degree is not conferred for a mere collection of credits. A well-balanced, unified, and complete program of study will be required, which may frequently exceed the minimum requirements as specified below under Additional Specific Requirements.

A student may meet the degree requirements by either full-time or part-time enrollment and by attendance in any combination of semesters and summer sessions. The student who interrupts the continuity of registration faces the possibility of not being granted permission to return.

## GRADE-POINT AVERAGE

A minimum grade-point average of 3.00 for work done at the University is required for graduation.

## TIME LIMITATION

All requirements for a master's degree, whether satisfied on the University Park Campus or elsewhere, must be met within six years or a period spanning seven consecutive summers.

## ADMISSION

In addition to the general University requirements for admission set forth at the beginning of this bulletin, adequate undergraduate preparation is required in the program in which the applicant expects to pursue advanced work. The specific courses and the total number of undergraduate credits required in various areas will be determined by the choice of program and can be ascertained from the descriptive statement appearing under the graduate program heading in the latter portion of this bulletin. An applicant who meets the necessary grade-point average but is deficient in course preparation may, under certain circumstances, be admitted to the Graduate School and be allowed to make up the undergraduate deficiencies. Under these circumstances the program will require more than the necessary period of residence. An applicant for admission to the M.Ed. program in most major programs is required to have had at least 18 credits in education and related psychology, and in certain major programs may be required to have had practice teaching.

After admission to a degree program, a student should confer with the head of the major department or program concerning the appointment of an adviser. The general guidance of a master's candidate is the responsibility of an adviser, or of a committee appointed in a manner to be determined by the major department or program in which the student is specializing. The adviser or the committee assists the student in planning a program of study. Although the adviser is frequently the supervisor of the thesis, this is not necessarily the case.

Requirements concerning courses, language proficiency, minors, comprehensive examinations, and other matters are sometimes made by departments or programs in addition to (but not in conflict with) the regulations of the Graduate School. For details the student should consult the head of the major department or program.

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### TRANSFER CREDIT

Subject to the limitations given, a maximum of 10 credits of high-quality graduate work done at another institution may be applied toward the requirements for the master's degree. However, credits earned to complete a previous master's degree may not be applied to a second master's degree program at The Pennsylvania State University.

The student should distinguish carefully between the transferability of credit and its applicability in a particular degree program. Approval to apply any transferred credits toward a degree program must be granted by the student's academic adviser, and the adviser must notify the Graduate School director of admissions, in writing, when such approval is granted. Transferred academic work must have been completed within five years prior to the date of admission to the Graduate School of The Pennsylvania State University, must be of at least B quality, and must appear on a graduate transcript. Credit earned externally in postbaccalaureate professional degree programs (law, medicine, etc.) is not transferable.

Pass-fail grades are not transferable to an advanced degree program unless the "Pass" can be substantiated by the former institution as having at least B quality.

Forms for transfer of credit may be obtained from the Office of Graduate Admissions, 201 Kern Graduate Building.

### EXAMINATIONS

A candidate may be required to pass in a satisfactory manner written or oral examinations designated by the program head. A candidate should consult the major department or program for special requirements.

Examinations to establish credit for work done in absentia or without formal class work may be used to remove undergraduate deficiencies, but *not* to earn credits toward an advanced degree. Arrangements are made by the student directly with the major department head or program chairman.

Graduate Record Examinations are designed to test information and abilities in basic fields of knowledge. Provisions are made on the campus for administering these examinations at scheduled times and upon request of students or department program chairmen. Informational materials may be obtained at the Graduate School Information Center on the first floor of Kern Graduate Building.

## M.A. and M.S. — ADDITIONAL SPECIFIC REQUIREMENTS

The Master of Arts and the Master of Science degrees have similar requirements, the general major area determining which degree is conferred. Programs for both degrees are strongly oriented toward research.

A minimum of 30 graduate credits is required, of which at least 20 must be earned at an established graduate campus of the University. Some graduate programs require additional credits; the exact number can be determined by consulting the specific program description in the subsequent section GRADUATE PROGRAMS, FACULTY, AND COURSES. A minor is not required of all candidates for the M.A. or M.S. degree. A department or committee in charge of a major program may require a candidate to offer work in a minor field, or the minor may be elected with the permission of the student's committee.

A minor consists of no fewer than 6 credits of integrated or articulated work in one field related to, but different from, that of the major. A minor program must meet the approval of the departments or committees responsible for both the major program and minor field.

The major department or the committee in charge of the major program is the judge as to the suitability of a field for the minor and of its relevance to the major. The minor field department has the responsibility of accepting or rejecting students, advising on courses to be taken by the candidate in the field, examining the candidate in the area of studies undertaken in the field, and certifying that the minor requirements have been met.

At least 18 credits in the 500 and 600 series, combined, must be included in the program. A minimum of 12 credits in course work (400 and 500 series), as contrasted with research, must be completed in the major program. A thesis is required of many candidates for these degrees. Details are given in the introductory paragraphs under the major program headings in the latter part of this catalog. If a student is required to write a thesis, at least 6 credits in thesis research (600 or 610) must be included in the program. If no thesis is required, at least 18 credits must be in 500-level courses.

A thesis is prepared under the direction of the department or program in which the candidate's major work is taken. Under certain conditions a student may complete the thesis off campus. To do so,



satisfactory arrangements must be made in advance with the adviser and the head of the major department or program.

Those candidates who are not required to write a thesis must present a suitable essay or paper. Its nature and extent shall be determined by the major program. The department head or program chairman shall report to the Office of Graduate Student Programs the title, the name of the faculty member under whom the student did the work, and whether the work was considered adequate. The program head may require one or more copies of the essay for the program's library or other files.

Some programs in the field of education offer the M.S. degree but prefer to admit students into the M.Ed. degree program. Other programs which emphasize research prefer to admit only students interested in pursuing the Ph.D. degree.

Requirements for the M.A. degree at the Capitol Campus differ somewhat from the above and are outlined under the major programs in American Studies and Humanities. These programs are available only at the Capitol Campus.

A *Thesis Information Bulletin*, which gives details concerning format, paper, typing, and other requirements, may be obtained at the Graduate School Office of Theses and Publications, 320 Kern Graduate Building. Following editorial review of the thesis by this office, it is expected that the student will submit a copy of the thesis, incorporating format corrections, to the office of the department or program head.

## **M.Adm. — ADDITIONAL SPECIFIC REQUIREMENTS**

The Master of Administration is a professionally oriented degree program intended for persons seeking or holding management positions in business firms, or engineering, scientific, technical, and health care organizations. The goals of the program are to develop competence in decision making, skill in interpersonal and group relations, the ability to integrate and interrelate the various functions of the firm, a sense of responsibility to society, and a commitment to ethical action within and outside the firm. The degree may be earned through evening full- or part-time study.

To earn the degree, eight foundation courses which are considered preparatory for this program must be taken prior to enrolling in the prescribed courses. The foundation courses may be satisfied by prior course work or by other means, as indicated in established waiver policy. Beyond the foundation courses a minimum of 30 credits are required. Research competence is demonstrated by completion of a professional paper. Students must register or complete registration for the professional paper (Bus. 554 — 3 credits) before or at the same time as they register for the last 6 credits of course work. If the paper has not been accepted and the student has registered for the required 3 credits, continuous registration for 1 credit per semester (summer session excepted) is required until the paper is accepted.

A description of the graduate program in Administration, which offers this degree, appears subsequently in this bulletin. Further information can be obtained from the Capitol Campus Graduate Admissions Office.

## **M.Agr. — ADDITIONAL SPECIFIC REQUIREMENTS**

The Master of Agriculture is a professional degree. Programs leading to this degree provide opportunities for students to increase their knowledge and competences in the various phases of agriculture. A student, according to individual objectives, may obtain intensive training encompassing a wide spectrum of subject matter area or intensive training in a specialized area. The emphasis of the program is to enable students to develop skills as professional practitioners in the communication of technical knowledge and its application to the solution of current and future technical, economic, and social problems of individuals and groups.

The head of the department or program chairman shall appoint a three-member committee to guide and monitor the candidate's professional development. Members of this committee must represent at least two departments. The chairman of the appointed committee shall serve as the candidate's adviser. The candidate will inform the committee of personal aspirations and background early in the program. The committee will suggest to the student how best to achieve these goals and the standard of professional competence required for the Master of Agriculture degree.

A minimum of 30 graduate credits is required, of which 20 credits must be earned in residence at

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the University Park Campus. A maximum of 10 credits may be earned in special problem-type courses.

The candidate must present an acceptable paper on a selected professional problem or a report of internship training. Up to 3 graduate credits will be given for an acceptable paper. The candidate may be required to provide one or more copies of the paper for the University.

The candidate's committee shall report, through the department head or program chairman, to the Office of Graduate Student Programs the title of the paper and whether the paper and the candidate's academic performance were considered satisfactory.

## **M.Arch. — ADDITIONAL SPECIFIC REQUIREMENTS**

The Master of Architecture is a professional degree and is planned to provide the depth and breadth of knowledge needed to enter the architectural profession and become a licensed professional architect following the required period of internship. Admission requirements include the equivalent of 40 credits in design-research work and a statement of purpose concerning the professional aims of the candidate. The program is available to candidates holding a B.A. or B.S. degree with a major in architecture or environmental design, or holding other nonprofessional degrees in architecture.

A minimum of 60 graduate credits at the 400 and 500 levels is required, 36 of which must be at the 500 level. A minimum of 30 credits must be taken at the University Park Campus. A thesis is optional. If a thesis is written, 6 credits of Arch. 600 must be completed. Professional areas of study include building design and architectural programming.

## **M.B.A. — ADDITIONAL SPECIFIC REQUIREMENTS**

The purpose of the Master of Business Administration degree program is to develop professional managerial knowledge and skills as these are applied to decisions in complex organizations. The curriculum was developed by the graduate business faculty to blend technical rigor, managerial theory, and integrative learning experiences through case studies and other teaching methods.

A minimum of 54 graduate credits is required, all at the 500 level. Thirty-nine credits must be in specified core courses. Also required are 15 credits in major field courses and electives (including a professional paper). Work for this degree may be started in the fall semester only. Applications must include the results of the Graduate Management Admission Test.

## **M.Ed. — ADDITIONAL SPECIFIC REQUIREMENTS**

The programs leading to the degree of Master of Education provide preparation for increased professional competence in education. They should be distinguished carefully from the research-oriented programs which lead to the academic degrees of Master of Arts or Master of Science. In most major programs the requirements for admission include 18 credits in education and related psychology.

A minimum of 30 graduate credits is required for the degree, of which at least 20 must be earned at an established graduate campus of the University; at least 24 must be in course work. This degree is also offered at the Capitol Campus and the King of Prussia Center for Graduate Studies.

## **MAJOR PROGRAMS IN THE FIELDS OF EDUCATION**

A student may major in one of the approved programs in education, such as curriculum and instruction, counselor education, or home economics education, and proceed under the guidance of a graduate faculty member in the appropriate major in education. At least 12 of the required credits in course work must be taken at the 500 level.

A program of this type requires at least 6 credits to be earned outside the programs in education, or the 6-credit requirement may be met with course work in the specific fields of educational psychology or educational theory and policy studies.

## **MAJOR PROGRAMS OUTSIDE THE FIELDS OF EDUCATION**

A student who is preparing to teach in a specific subject-matter field, such as economics, mathematics, or German, may choose such a program as a major and take a majority of work in it under the



guidance of the department offering that major. A student wishing to study in a broader area may choose a major such as human development and family studies, earth sciences, or extension education and take at least 24 credits in the area under the guidance of the committee in charge of the major.

Each candidate is required to earn 6 credits in education as directed by the faculty of one of the approved graduate programs in education. The 6 credits may be taken in educational theory and policy, which includes courses in comparative education; history, sociology, and philosophy of education; and educational psychology.

### THESIS OR PAPER

Six credits may be granted for an approved thesis. A candidate who does not elect to write a thesis is required to present an essay or paper. It must be of considerable proportion, indicating capacity to describe a serious intellectual experience adequately in writing, and giving unmistakable evidence of ability to formulate and state meaningfully the purpose of an investigation, study, critical analysis, or evaluation; to acquire and analyze information; to draw conclusions logically; and to relate findings to professional problems and practices. The nature and extent of this piece of writing, whether it be required in connection with a course or independent of course work, and when it is to be undertaken shall be determined by the major program. The program chairman shall report to the Office of Graduate Student Programs the title, the name of the faculty member under whom the student did the work, and whether the work was considered adequate. It is the right, but not the responsibility, of the program chairman to require one or more copies of the essay for the program's library or other files.

## M.Eng. — ADDITIONAL SPECIFIC REQUIREMENTS

The programs leading to the degree of Master of Engineering provide training for advanced professional competence in the several fields of engineering. They should be distinguished carefully from the research-oriented programs which lead to the academic degree of Master of Science.

A minimum of 30 graduate credits is required, of which 20 must be earned at an established graduate campus of the University. At least 12 credits must be earned in graduate courses (500 series).

A scholarly written report on a developmental study involving at least one area represented in the candidate's course work is required as an integral part of the program. The report must be comparable in its level of work and quality to a graduate thesis. The topic of the developmental study is subject to prior approval by the department in which the candidate's major work is taken, and preparation of the written report shall be under the direction of that department.

Work for this degree is not required to be done specifically on the University Park Campus. A complete program of study can be pursued at the Capitol Campus, at the Behrend College, or at the King of Prussia Center for Graduate Studies of The Pennsylvania State University.

## M.E.P.C. — ADDITIONAL SPECIFIC REQUIREMENTS

The Master of Environmental Pollution Control is an intercollege professional degree designed for students who are interested in pursuing a career in the field of environmental pollution control. Special requirements include 9 credits of core courses covering air and water pollution control and solid waste management and participation in the environmental pollution control seminar program. A minimum of 30 graduate credits is required, 20 of which must be taken at either the University Park Campus or the Capitol Campus. Nine of these 30 credits must be taken at the 500 level; the E.P.C. 590 seminars and any 500-level paper-writing courses may not be counted as part of this 9-credit requirement. A master's paper must be submitted by all M.E.P.C. candidates.

## M.F.A. — ADDITIONAL SPECIFIC REQUIREMENTS

The programs leading to the degree of Master of Fine Arts provide training for professional competence in the several specialized areas of the arts. They should be distinguished carefully from the research-oriented programs which lead to the academic degree of Master of Arts with a major in art or theatre arts.

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A minimum of 48 credits is required, of which at least 38 must be earned at The University Park Campus. The larger part of these credits should be above the 400 level, but the needs of the student shall be considered in arranging the best combination of courses and research for the preparation of the candidate in a particular field.

A professional creative project is required. This project shall include a monograph in support of the creative or interpretative aspect of the program; the project and monograph shall represent a minimum of 6 credits on the 600 level.

### **M.F.R. — ADDITIONAL SPECIFIC REQUIREMENTS**

The program leading to the degree of Master of Forest Resources provides training for increased professional competence in the several specialized areas of forest resource management and forest products. It should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Science with a major in forest resources.

A minimum of 30 graduate credits is required, of which at least 20 must be earned at an established graduate campus of the University. At least 12 credits must be in courses at the 500 level, excluding F. P. 596, For. 596, and Wildl. 596, and 6 credits of statistics are required.

A candidate for the degree of Master of Forest Resources may elect a minor with the permission of the committee. A minor consists of no fewer than 6 credits of integrated work in one field related to, but different from, that of the major. A minor program must meet the approval of the department or committee responsible for the minor field.

Each candidate is required to submit an acceptable paper which demonstrates an ability to apply to the professional field the knowledge gained during his or her program. Six to 9 graduate credits will be given for this paper, which will be evaluated by the student's committee and defined in an oral examination.

### **M.Mus. — ADDITIONAL SPECIFIC REQUIREMENTS**

The program leading to the degree of Master of Music provides training for increased professional competence in music. It should be distinguished carefully from the research-oriented program which leads to the academic degree of Master of Arts with a major in music history.

A minimum of 36 credits is required, of which at least 30 must be earned at the University Park Campus. The larger part of these credits should be above the 400 level, but the needs of the student shall be considered in arranging the best combination of courses and research for the preparation of the candidate.

A professional project, either creative or interpretative, is required. This project shall include a monograph in support of the creative or interpretative aspect of the program.

### **M.Ps.Sc. — ADDITIONAL SPECIFIC REQUIREMENTS**

The Master of Psychosocial Science degree, community psychology option, is a nontraditional program designed to train students to increase the social effectiveness of community institutions. The skills emphasized are the ability to recognize community problems, to outline and implement solutions to them, and to evaluate the efficacy of the solutions. Part of the curriculum is a field-based experience that includes employing one or several of these skills.

Forty-five credits are required, 24 at the 500 level. A faculty-supervised project will focus on the applied use of community psychology. The paper produced in this effort will be orally defended.

### **M.P.A. — ADDITIONAL SPECIFIC REQUIREMENTS**

The Master of Public Administration is a professional degree for students who are planning careers in public administration in local, state, and national governmental jurisdictions or in international, private, or voluntary agencies. The M. P.A. degree is offered at the University Park Campus, the Capitol Campus, and the King of Prussia Center for Graduate Studies.

The M.P.A. degree offered at University Park and King of Prussia requires a minimum of 30 grad-



uate credits, of which 27 must be earned at University Park or King of Prussia Campus. The greater portion of the courses must be at the 500 level. An M.P.A. research paper also will be required and will carry graduate credit. A comprehensive final examination will be given to all candidates.

The M.P.A. degree offered at the Capitol Campus at Middletown requires a minimum of 45 graduate credits including a 9-credit field study (internship) experience and a professional master's project. The 9-credit field study requirement may be waived for students who have at least three years of full-time professional experience in relevant administrative or staff work. There is no comprehensive final examination, but an oral defense of the master's project report is required.

The program leading to the Master of Public Administration degree should be distinguished from the research-oriented program which leads to the academic degree of Master of Arts with a major in political science, in which the candidate may specialize in public administration.

## **M.R.P. — ADDITIONAL SPECIFIC REQUIREMENTS**

The Master of Regional Planning is a professional degree for students interested in a multidisciplinary approach to the problems of regional and community development and resource management. The program provides the student with a solid background in planning theory and techniques, emphasizing planning within a multijurisdictional context in both urban and rural areas. The program provides flexibility for students to develop an area of specialization or to pursue a concurrent degree in a discipline related to planning.

For the M.R.P. degree at the University Park Campus, a minimum of 38 approved graduate credits is required, of which 28 must be earned at University Park or at a graduate center of the University. Six graduate credits will be earned in preparing (1) a thesis or (2) a professional paper comparable in quality and scope to a graduate thesis. In addition, the student must have (1) documented evidence of a planning related work experience or 3 graduate credits in a planning practicum; and (2) approval of prior course work in the areas of economics, geography, public administration, and statistics, or 3 graduate credits must be earned in approved courses in each of these areas.

The M.R.P. degree at the Capitol Campus at Middletown requires a minimum of 45 credits. Of that number, required core courses total 21 credits. In addition, 6 or 9 credits must be earned in preparing (1) a project report comparable in quality to a graduate thesis, or (2) a master's thesis. Elective courses in planning organization and administration, natural resources, physical planning, policy and program planning, and computer applications in planning, along with selected courses available in graduate programs pertinent to a professional career in planning, make up the remaining credits.

## **PENNSYLVANIA DEPARTMENT OF EDUCATION CERTIFICATE CANDIDATES**

Candidates for all administrative, supervisory, and educational specialist certificates issued by the Pennsylvania Department of Education on recommendation of the University are advised that a precertification competency examination is required. This examination samples the knowledge base needed by teachers and other educators in order to educate the handicapped in the least restrictive environment. The examination is individually administered during the semester preceding the candidate's internship or major practicum. Examination application forms are available from the Office of Certification and Education Services, College of Education, 181 Chambers Building. There is no charge for the first trial. For the second trial a fee of \$10 is required. The third and all subsequent trials require a fee of \$20 each. Information containing several alternative methods of preparing for the examination may be obtained from graduate faculty advisers in the College of Education or from the college's Office of Certification and Educational Services at the address shown above.

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# GRADUATE PROGRAMS, FACULTY, AND COURSES

## ACOUSTICS (ACS)

JIRI TICHY, *Chairman of the Committee on Acoustics*  
Applied Research Laboratory, Applied Science Building  
814-865-6364

**Degrees Conferred:** Ph.D., M.S., M.Eng.

### Senior Members of the Graduate Faculty

Carter L. Ackerman, Ph.D. (Penn State) *Associate Professor of Engineering Research*  
Walter L. Baker, M.S. (Penn State) *Professor of Engineering Research*  
John L. Brown, Jr., Ph.D. (Brown) *Professor of Electrical Engineering*  
Robert S. Brubaker, Ph.D. (Illinois) *Professor of Speech Communication*  
Sabih I. Hayek, D.Eng. Sc. (Columbia) *Professor of Engineering Mechanics*  
Gerald C. Lauchle, Ph.D. (Penn State) *Research Associate at the Applied Research Laboratory*  
Suzanne T. McDaniel, Ph.D. (Penn State) *Senior Scientist at the Applied Research Laboratory*  
Paul L. Michael, Ph.D. (Pittsburgh) *Professor of Environmental Acoustics*  
Vernon H. Neubert, D.Eng. (Yale) *Professor of Engineering Mechanics*  
Miles T. Pigott, Ph.D. (Penn State) *Professor of Engineering Research*  
Gerhard Reethof, Sc.D. (M.I.T.) *Professor of Mechanical Engineering*  
Richard O. Rowlands, M.S. (University of Wales) *Professor of Engineering Research (Emeritus)*  
Leon H. Sibul, Ph.D. (Penn State) *Senior Research Associate, Applied Research Laboratory*  
Eugen J. Skudrzyk, Ph.D. *Professor Emeritus of Physics*  
William Thompson, Jr., Ph.D. (Penn State) *Associate Professor of Engineering Science*  
Jiri Tichy, D.Sc. (Prague Inst. of Tech.) *Professor of Architectural Engineering*  
Geoffrey L. Wilson, Ph.D. (Loughborough Tech., England), P.E. *Associate Professor of Engineering Research*

### Associate Members of the Graduate Faculty

Gordon Bienvenue, Ph.D. (Penn State) *Research Associate in Audiology*  
Robert W. Farwell, Ph.D. (Penn State) *Associate Professor of Engineering Research*  
W. Jack Hughes, Ph.D. (Penn State) *Research Associate at the Applied Research Laboratory*  
Roger L. Kerlin, Ph.D. (Penn State) *Research Associate at the Applied Research Laboratory*  
James M. Lawther, Ph.D. (Penn State) *Associate Professor of Engineering Research*  
John A. Macaluso, Ph.D. (Penn State) *Assistant Professor of Engineering Research*  
Julian D. Maynard, Ph.D. (Princeton) *Assistant Professor of Physics*  
Oliver H. McDaniel, Ph.D. (Penn State) *Research Associate, Mechanical Engineering*  
Norman B. Miller, M.S. (Louisiana State) *Senior Research Associate at the Applied Research Laboratory*  
James H. Prout, M.S. (Michigan) *Associate Professor of Engineering Research*  
Dennis W. Ricker, Ph.D. (Purdue) *Senior Research Associate at the Applied Research Laboratory*  
Alan D. Stuart, Ph.D. (Penn State) *Research Associate at the Applied Research Laboratory*

The aim of this intercollege program is to enable the student interested in acoustics to obtain an integrated program of courses covering the fundamentals of acoustical science and the biological, communications, and engineering applications of acoustics.

Programs are arranged through a selection of appropriate courses offered by several departments in the Colleges of Science, Engineering, and Education, as well as those specifically in the area of acoustics.

Areas of concentration include acoustic signal processing, architectural and building acoustics, noise and vibration, physical acoustics, speech and hearing, and underwater acoustics. Thesis research in the various areas may be conducted in acoustical laboratories which are located throughout the campus and are administered separately by the departments to which they are connected. These

laboratories are the Applied Research Laboratory, the Physical Acoustics Laboratory, the Noise Control Laboratory, the Shock and Vibration Laboratory, the Architectural Acoustics Laboratory, the Environmental Acoustics Laboratory, and the Speech Laboratory.

## Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Entering students should hold a bachelor's degree in physics, biology, engineering, architecture, mathematics, psychology, speech and hearing, or in a closely related field; they should have had at least one year of physics and mathematics including integral calculus. Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

## Doctoral Degree Requirements

The communication and foreign language requirement for the Ph.D. degree may be satisfied by competence in the use of computer language, as well as a reading knowledge of a foreign language.

## Other Relevant Information

In addition to the acoustics courses listed below, the following courses on acoustics and closely related areas are available: Aersp. 412, 444, 506, 511, 515, 517; A.E. 458, 542; Cm.Dis. 430, 522, 531, 532, 534; E.E. 459, 560, 561, 562; E.Mch. 401, 412, 516, 521, 522, 524A,B, 525, 527, 528, 570; M.E. 458, 522; Phys. 443, 533; Sp.Com. 413, 431.

## Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## ACOUSTICS (ACS)\*

401. GENERAL ACOUSTICS (3)

402. INTRODUCTION TO ACOUSTICS (3)

403. MODERN ELECTRONICS FOR ENGINEERING ACOUSTIC APPLICATIONS (3)

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

510. FUNDAMENTALS OF ACOUSTICS (5) In-depth presentation of the fundamental principles of acoustics; designed to prepare students to take advanced courses in acoustics.

511. UNDERWATER SOUND PROPAGATION (3) Theoretical and empirical treatment of sound propagation in the ocean, including effects of the environment, characteristics of targets, and transducers.

512. SONAR ENGINEERING (3) Theoretical and empirical treatment of problems related to the use of underwater sound in target detection and ranging.

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\*A course abbreviation, a number, and a title designate each course. Course designations and official abbreviations are listed above the first course in each group. The figures in parentheses following the course title show the number of credits which may be granted for that course. In the case of courses with variable credits, the number of credits which may be earned in a single semester is determined by the department or program offering the course.

A department or major program may schedule an entire section of a course below the 400 level for fewer credits than the maximum authorized. In 400- and 500-series courses, an individual student may schedule fewer credits than the maximum number but in no case more than the maximum number authorized.

All courses listed under graduate majors may not be required in the particular major.



513. **MODERN ACOUSTIC SIGNAL PROCESSING (3)** Probability review, representation of signals, noise processes, optimum filtering, ambiguity functions, linear and nonlinear signal processing, application to sonar systems.
514. **ELECTROACOUSTIC TRANSDUCERS (3)** The theory, design, and calibration of passive, linear, reciprocal electroacoustic transducers for use in both air and water media. Prerequisite: Phys. 443 or Acs. 510.
515. **ACOUSTICS IN FLUID MEDIA (3)** Wave propagation in stationary and moving fluids; acoustic radiation and scattering; standing waves in ducts and cavities. Prerequisites: E.Mch. 524A; Phys. 443 or Acs. 510.
516. **ACOUSTICAL DATA MEASUREMENT AND ANALYSIS (3)** Presents the engineering applications of recent developments in correlation and spectral analysis to acoustical measurement problems.
517. **TECHNIQUES FOR SOLVING ACOUSTIC FIELD PROBLEMS (3)** Transient and time-harmonic acoustic radiation and scattering problems involving various boundary conditions, solved by exact, approximate, and numerical methods. Prerequisites: Acs. 515, E.Mch. 524B.
518. **ADAPTIVE SIGNAL PROCESSING (3)** Basic concepts and application of adaptive signal processing techniques; adaptive filters, beamformers; optimum space/time processors and their adaptive implementation; adaptive algorithms. Prerequisites: E.E. 562; E.E. 459 or Math. (Stat.) 409.
590. **COLLOQUIUM (1-3)**
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**

## ADMINISTRATION (ADMIN)

HAROLD L. GILMORE, *Head, Division of Business Administration*  
 The Capitol Campus  
 E-355 Olmsted Building  
 Middletown, PA 17057  
 717-948-6140

**Degree Conferred:** M.Adm.

### Senior Members of the Graduate Faculty

Robert J. Brown, Ph.D. (New York University) *Associate Professor of Finance*  
 Terence A. Brown, D.B.A. (Maryland) *Associate Professor of Transportation and Marketing*  
 Jacob De Rooy, Ph.D. (Rutgers) *Associate Professor of Managerial Economics and Statistics*  
 Carolyn R. Dexter, Ph.D. (Columbia) *Associate Professor of Sociology*  
 Harold L. Gilmore, Ph.D. (Syracuse) *Professor of Management*

### Associate Members of the Graduate Faculty

Joseph C. Atkins, Ph.D. (Penn State) *Assistant Professor of Finance*  
 Alexander P. Bhanos, Ph.D. (University of Illinois) *Assistant Professor of Management*  
 Barbara Lee Bleau, Ph.D. (Penn State) *Assistant Professor of Mathematics*  
 George S. Cole, Ph.D. (Michigan State) *Assistant Professor of Management*  
 Refik Culpan, Ph.D. (New York University) *Assistant Professor of Management*  
 Robert R. Elliot, Ph.D. (University of Massachusetts) *Assistant Professor of Management Science*  
 Harold J. Hoy, M.B.A. (Hartford) *Instructor in Marketing*  
 Andrew B. Jack, Ph.D. (Harvard) *Assistant Professor of Marketing*  
 Donald E. Kreps, D.B.A. (George Washington) *Assistant Professor of Management*  
 Vedula N. Murti, Ph.D. (Pennsylvania) *Assistant Professor of Economics and Statistics*  
 Kurt H. Parkum, Ph.D. (University of Wisconsin) *Assistant Professor of Health Care and Organizational Behavior*  
 John T. Redington, Jr., Ph.D. (Penn State) *Instructor in Marketing*

The Master of Administration is a professionally oriented degree program intended for persons seeking or holding management positions in business firms, or engineering, scientific, technical, and health care organizations. The goals of the program are to develop competence in decision making, skill in interpersonal and group relations, the ability to integrate and interrelate the various functions

of the firm, a sense of responsibility to society, and a commitment to ethical action within and outside the firm. The degree may be earned through evening full- or part-time study.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in the program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

An applicant must present a baccalaureate degree from an accredited institution in any field. Admission decisions are based on an applicant's junior-senior cumulative grade-point average, Graduate Management Admission Test (GMAT) score, postgraduate work experience, and the degree of fit between the objectives of the student and those of the program. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Scores from the GMAT and TOEFL (required of students whose native language is not English) must be submitted before the applicant is considered for admission. The GMAT is administered by the Educational Testing Service four times a year. For dates, locations, and any other information about the test, write to Graduate Management Admissions Test, Box 966, Educational Testing Service, Princeton, NJ 08541. All arrangements for taking the test are made directly with the Educational Testing Service by the applicant.

Admission is open each semester of the academic year. Deadlines for applying are not specified, but six to eight weeks should be allowed for processing the application after all required information is received. Applications for admission may be requested from the Capitol Campus Graduate Admissions Office.

### Degree Requirements

To earn the degree, eight foundation courses which are considered preparatory for this program must be taken prior to enrolling in the prescribed courses. The foundation courses may be satisfied by prior course work or by other means, as indicated in established waiver policy detailed in available program literature. Beyond the foundation courses, a minimum of 30 credits are required. Research competence is demonstrated by completion of a professional paper. Students must register or complete registration for the professional paper (Bus. 554 - 3 credits) before or at the same time as they register for the last 6 credits of course work. If the paper has not been accepted and the student has registered for the required 3 credits, continuous registration for 1 credit per semester (summer session excepted) is required until the paper is accepted.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

### COURSES +

BUS. 520. ADMINISTRATIVE MODELS (3) Formulation and solution of decision models for administrative problems. Analysis of decision making under certainty, risk, and uncertainty. Prerequisite: Bus. 492.

BUS. 552. ADVANCED MANAGERIAL STATISTICS (3) Application of statistical methods for analyzing the relationships between two or more variables, such as multiple regression. Prerequisite: Bus. 491.

BUS. 554. MASTER'S PROJECT (1-3) Development of an original master's project in the student's area of professional interest. Prerequisite: Student must enroll for this course and have an approved proposal prior to registering for the last 6 credits of the degree program.

BUS. 556. ECONOMIC AND BUSINESS FORECASTING (3) Application and evaluation of methods for forecasting regional economic change and business activity. Prerequisites: Bus. 491, Ecnms. 310.

BUS. 560. SAMPLING THEORY AND PRACTICE (3) Study of scientific method of obtaining representative samples, collection of information, techniques of estimation. Prerequisite: Bus. 491.

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+ Course descriptions not given below can be found under the designated field of study.



**BUS. 584. BUSINESS AND SOCIETY (3)** Evolution of business relationships with society and government: legal, political, and social environment of business. Prerequisite: Ecnms. 510.

**\*BUS. 588. BUSINESS POLICY FORMULATION (3)** Analysis of administrative problems from a total organization viewpoint. Case studies of actual organizations are used for analysis. Prerequisite: all course work or permission of instructor.

**BUS. 589. SMALL BUSINESS MANAGEMENT PRACTICUM (1-3)** Advanced study and practice in small business management through field assignments with cooperating firms to analyze and solve managerial problems.

**BUS. 590. COLLOQUIUM (1-3)**

**BUS. 596. INDIVIDUAL STUDIES (1-9)**

**BUS. 597. SPECIAL TOPICS (1-9)**

**ECNMS. 510. MANAGERIAL ECONOMICS (3)** Development of economic models for analyzing demand, cost behavior, production relationships, pricing policies, and capital budgeting in the firm. Prerequisites: Ecnms. 310, 311, Bus. 492.

**FINAN. 530. ADVANCED FINANCIAL MANAGEMENT (3)** The financial aspects of management, including subjects of general interest to managers. Prerequisites: Bus. 492, Finan. 492.

**FINAN. 531. MANAGING FINANCIAL OPERATIONS (3)** A course for financial managers; working capital management; financial planning, financial controls, reporting, financial strategies; theory and practice. Prerequisites: Bus. 520, Finan. 492.

**FINAN. 596. INDIVIDUAL STUDIES (1-9)**

**FINAN. 597. SPECIAL TOPICS (1-9)**

**I.B. 501. COMPARATIVE BUSINESS SYSTEMS (3)** Conceptual approach analyzing and predicting influences of social, political, and economic norms and values upon diverse societies' managerial decision making.

**MNGMT. 500. ADMINISTRATION THEORY (3)** History, significance, and functions of administration. Theories of leadership, authority, decision making, rationality, and efficiency.

**MNGMT. 505. PERSONNEL MANAGEMENT (3)** Problems in effectively selecting, utilizing, and developing human resources from the viewpoint of the total organization — both private and public.

**MNGMT. 510. (P.ADM. 510) ORGANIZATIONAL BEHAVIOR (3)** Examination of concepts of human behavior in formal organizations, systems analysis, conceptual models, and decision processes. Prerequisite: all preparatory requirements.

**MNGMT. 511. (P.ADM. 511) ORGANIZATIONAL CHANGE AND DEVELOPMENT (3)** Theory of organizational change and development; case analysis of applications in actual situations. Prerequisites: Mngmt. 500, 510.

**MNGMT. 515. (P.ADM. 515) LABOR-MANAGEMENT RELATIONS (3)** Labor relations issues; collective bargaining agreement, negotiations, and administration; legal framework of collective bargaining; labor relations in larger social context.

**MNGMT. 522. OPERATIONS MANAGEMENT (3)** Integration and application of decision making to operational and policy problems within the business firm. Prerequisite: Bus. 492.

**MNGMT. 596. INDIVIDUAL STUDIES (1-9)**

**MNGMT. 597. SPECIAL TOPICS (1-9)**

**MRKT. 570. ADVANCED MARKETING MANAGEMENT (3)** Analysis of management's marketing problems, including marketing analyses, pricing, channels of distribution, promotion, competition, product strategies, and marketing research. Prerequisites: Ecnms. 510, Mngmt. 510, Mrkt. 370.

**MRKT. 571. CONSUMER BEHAVIOR (3)** Factors influencing buyer behavior; contributions of the behavioral sciences to the study of selected phenomena. Prerequisite: Ecnms. 510.

\*Course to be taken during student's last semester — recommended tool courses must be completed.

## ADULT EDUCATION

**MRKT. 572. RESEARCH AND MARKETING MANAGEMENT (3)** Management information needs, evaluation of search proposals and findings, methods of data collection and analysis, integration of research and decisions. Prerequisite: Mrkt. 570.

**MRKT. 596. INDIVIDUAL STUDIES (1-9)**

**MRKT. 597. SPECIAL TOPICS (1-9)**

**P.ACC. 540. MANAGERIAL ACCOUNTING (3)** Fundamental financial and managerial accounting concepts and issues from the viewpoint of the report user. Prerequisite: P.Acc. 491.

**P.ACC. 596. INDIVIDUAL STUDIES (1-9)**

**P.ACC. 597. SPECIAL TOPICS (1-9)**

## ADULT EDUCATION (ADTED)

GORDON C. GODBEY, *In Charge of Graduate Programs in Adult Education*  
301 Rackley Building  
814-863-3781

**Degrees Conferred:** D.Ed., M.Ed.

### Senior Members of the Graduate Faculty

Eunice N. Askov, Ph.D. (Wisconsin) *Professor of Education*  
Gordon C. Godbey, Ed.D. (Harvard) *Professor of Education*  
Carl A. Lindsay, Ph.D. (Penn State) *Associate Professor of Education*  
Sebastian Martorana, Ph.D. (Chicago) *Professor of Education*  
William Toombs, Ph.D. (Michigan) *Professor of Education*  
Susan F. Weis, Ph.D. (Penn State) *Associate Professor of Home Economics Education*

### Associate Members of the Graduate Faculty

Hugh W. Fraser, Ed.D. (Rochester) *Associate Professor of Educational Administration*  
Armando Villarreal, Ph.D. (Michigan State) *Adjunct Assistant Professor of Education*

The programs in Adult Education are interdisciplinary, and students are advised to seek learning beyond the minor, in supporting fields within the University. The program prepares students for both policy development and the immediate aspects of carrying forward the work of the field of adult education.

Flexibility in graduate programs permits specialization in such aspects of adult education as adult learning, counseling the adult learner, program planning and development, administration, teaching adults at the ABE/GED levels, continuing education in higher education, and industrial training and staff development for a variety of types of organizations. Internships and practica for inexperienced students can be arranged at local, state, and national levels. An emphasis on distance education is available for those students who anticipate developmental work in the international field.

Scheduling is arranged, so far as possible, to accommodate the employed student, although full-time study is recommended. Entering students are expected to have a concept of their major interest and possible thesis subject, which may be developed during course work.

### Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in the program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.

The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Applicants with a total Verbal and Quantitative score above 1100 on the GRE, a junior-senior average of 3.00, and a graduate average of 3.50 are usually admitted to the D.Ed. program. Applicants with a junior-senior average of 2.70, a graduate average of 3.20, and a GRE total score of 1000 but with special backgrounds, abilities, and interests also may be admitted to the doctoral pro-



gram with only the baccalaureate degree, but they will earn the master's degree en route. A sample of serious student writing is required for each degree.

### **Master's Degree Requirements**

M.Ed. students are required to write a master's paper in lieu of a thesis, in addition to the required 33 credits of course work. A minimum of 18 credits in course work must be taken at the 500 level, with at least 15 credits being in Adult Education courses.

### **Doctoral Degree Requirements**

D.Ed. students who do not have previous experience in adult education are expected to acquire the equivalent of one year of experience prior to receiving their D.Ed. degree. During the comprehensive examination, in addition to being examined in their area of specialization, all D.Ed. students will be examined in the common adult education areas: history and philosophy; curriculum, advising, and instruction; organization and administration; adult education clientele; and research methodology.

### **Student Aids**

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## **ADULT EDUCATION (ADTED)**

460. INTRODUCTION TO ADULT EDUCATION (3)

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

505. THE TEACHING OF ADULTS (3) Examination of direct and indirect teaching; contracts, application of current technology, andragogy, motivation, evaluation; knowledge of research. Prerequisite: Adt.Ed. 460.

506. PROGRAM PLANNING IN ADULT EDUCATION (3) Intensive study of theoretical foundations, policies, evaluation models, methods, and materials in program planning in adult education. Prerequisites: Adt.Ed. 460, 505.

507. RESEARCH AND EVALUATION IN ADULT EDUCATION (3) Guided discussion and reading in selected research and evaluation methods and trends as applied in adult education settings. Prerequisites: Adt.Ed. 460; introductory statistics course; introductory research design course.

510. HISTORICAL AND SOCIAL ISSUES IN ADULT EDUCATION (3) Social and historical foundations of adult education in the United States and selected nations. Prerequisite: Adt.Ed. 460.

560. (RCLEd. 560) TEACHING READING TO COLLEGE STUDENTS AND ADULTS (3) Reading literacy for adults, including college reading, Adult Basic Education (ABE), and General Educational Development (GED) programs. Prerequisite: RCLEd. 440 or teaching experience.

570. INTERNATIONAL ADULT EDUCATION (3) Survey of adult education theory and practice outside North America, including international agency involvement. Prerequisite: Adt.Ed. 460.

575. (Ed.Adm. 575) ADMINISTRATION OF ADULT EDUCATION (3) Organization of a program of adult education; legal status, finances, selection of teachers, learning personnel, housing; other administrative problems. Prerequisite: Ed.Adm. 480 or teaching or administrative or supervisory experience.

588. PROFESSIONAL SEMINAR: RESEARCH AND ADULT EDUCATION (3) Review of research in adult education, current and past, with analysis of its directions, effects, methodology, quality, financing, and prospects. Prerequisites: Adt.Ed. 460, 507.

595. INTERNSHIP IN ADULT EDUCATION (3-9) Supervised student internship in adult education agency. Prerequisite: Adt.Ed. 460.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

## AEROSPACE ENGINEERING (AERSP)

BARNES W. McCORMICK, *Head of the Department*  
233 Hammond Building  
814-865-2569

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Joseph J. Eisenhuth, Ph.D. (Penn State) *Associate Professor of Aerospace Engineering*  
J. William Holl, Ph.D. (Penn State) *Professor of Aerospace Engineering*  
Budugur Lakshminarayana, Ph.D., D.Eng. (Liverpool) *Professor of Aerospace Engineering*  
Barnes W. McCormick, Jr., Ph.D. (Penn State), P.E. *Professor of Aerospace Engineering*  
Philip J. Morris, Ph.D. (Southampton) *Associate Professor of Aerospace Engineering*  
Blaine R. Parkin, Ph.D. (California Tech.), P.E. *Professor of Aerospace Engineering*  
Thomas M. York, Ph.D. (Princeton) *Professor of Aerospace Engineering*

### Associate Members of the Graduate Faculty

Robert G. Melton, Ph.D. (Virginia) *Assistant Professor of Aerospace Engineering*  
Michael M. Micci, Ph.D. (Princeton) *Assistant Professor of Aerospace Engineering*  
Hubert C. Smith, Ph.D. (Virginia) *Assistant Professor of Aerospace Engineering*  
Donald E. Thompson, Ph.D. (Penn State) *Senior Research Associate*

Opportunities for graduate study are available in the following areas: low-speed aerodynamics, V/STOL aircraft, turbulence, astrodynamics, turbomachinery, aeroacoustics, plasma dynamics, rarefied gas dynamics, hydrodynamics, stability and control of aerospace vehicles, aeroelasticity, aerospace structures, astronautics, and computational fluid dynamics.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

The entering M.S. student must hold a bachelor's degree in physical science, mathematics, or engineering and may be required to complete (without degree credit) undergraduate course work in fluid and solid mechanics and intermediate mathematical analysis, if not already completed. Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission to the M.S. program. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. The best-qualified applicants will be accepted up to the number of spaces that are now available to new students. Satisfactory completion of a master's program in physical science, mathematics, or engineering is required for admission to the Ph.D. program.

### Master's Degree Requirements

The course requirements for a student pursuing an M.S. degree are as follows: 6 credits of advanced mathematics selected from a department list, 12 credits or less of adviser-approved 400-level courses, 6 credits or more of adviser-approved 500-level courses, and 6 credits of thesis research. A total of 30 credits are required. Preparation of an M.S. thesis is required for graduation.

### Doctoral Degree Requirements

The communication and foreign language requirement for the Ph.D. degree may be satisfied by a reading knowledge of two foreign technical languages, an in-depth knowledge of one foreign language, or a reading knowledge of one foreign language in addition to meaningful knowledge in a cultural subject of broad significance. In addition, Ph.D. students are required to demonstrate high-level competence in the use of the English language. Ph.D. course requirements are decided by the candidate's doctoral committee on an individual basis.

The following examinations are administered by the committee during the progression of the Ph.D. program. The candidacy examination is given as a preliminary aptitude test before the end of the second semester. A comprehensive examination covering the major and minor fields of study is adminis-



tered after the candidate has substantially completed the required course work. The final oral examination, which is related mainly to the thesis, is given after the candidate has satisfied all of his or her degree requirements.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

**AMELIA EARHART FELLOWSHIP** — Available to a woman graduate student in aerospace engineering; stipend \$5,000.

**W. S. ELLIOTT FELLOWSHIP** — Available to a graduate student who is a graduate of The Pennsylvania State University and is interested in engineering research; stipend variable. Apply to Office of the Dean, College of Engineering, 101 Hammond Building.

**TAU BETA PI FELLOWSHIP** — Open to any member of Tau Beta Pi, the engineering honor society, for a year of advanced study. Up to eighteen awards of \$3,500 each are available. Applications and information may be obtained from the Office of the Dean, College of Engineering, 101 Hammond Building. Application deadline is February 15.

**NASA TRAINEESHIPS** — Available to B.S. graduates in engineering, physical sciences, mathematics, and computer science pursuing graduate studies in computational fluid dynamics. Applications and information may be obtained from Dr. B. Lakshminarayana, 153 Hammond Building.

### AEROSPACE ENGINEERING (AERSP)

- 402. AEROSPACE DESIGN (2-4)  
     *Unit A. Preliminary Design* (2)  
     *Unit B. Detailed Design* (2)
- 403. DESIGN OF AIR TRANSPORT SYSTEMS (3)
- 405. AERODYNAMICS LABORATORY (2)
- 407. AERODYNAMICS OF V/STOL AIRCRAFT (3)
- 410. AEROSPACE PROPULSION (3)
- 411. AEROELASTICITY (3)
- 412. TURBULENT FLOW (3)
- 413. STABILITY AND CONTROL OF AIRCRAFT AND MISSILES (3)
- 415. PHYSICAL GAS DYNAMICS (3-6)
- 416. AEROSPACE RESEARCH PROJECTS (2)
- 417. AEROSPACE UNDERGRADUATE THESIS (3)
- 420. PRINCIPLES OF FLIGHT TESTING (3)
- 421. (M.E. 421)\* INTERMEDIATE VISCOUS FLOW (3)
- 423. INTRODUCTION TO NUMERICAL METHODS IN FLUID DYNAMICS (3)
- 425. THEORY OF FLIGHT (3)
- 430. SPACE PROPULSION AND POWER SYSTEMS (3)
- 444. NOISE POLLUTION OF FLUID DYNAMIC ORIGIN (3)
- 450. ORBIT AND ATTITUDE CONTROL OF SPACECRAFT (3)
- 496. INDEPENDENT STUDIES (1-18)
  
- 504. AERODYNAMICS OF V/STOL AIRCRAFT (3) Jet wings, high lift devices, propellers and ducted propellers, circulation and boundary layer control, unsteady airfoil theory. Prerequisite: Aersp. 407.
- 505. AERO- AND HYDROELASTICITY (3) Interaction of elastic systems having several degrees of freedom with fluid flows in various configurations.
- 506. CAVITATION (3) Flow regimes, dynamics of cavitation, prediction of the minimum pressure in the fluid, scale effects, effect of surface irregularities.
- 507. THEORY AND DESIGN OF TURBOMACHINERY (3) Theory and principles of machinery design: compressors, turbines, pumps, and rotating propulsors; opportunity to work out design examples.
- 508. FOUNDATIONS OF FLUID MECHANICS (3) Mathematical review, fluid properties, kinematics, conservation laws, constitutive relations, similarity principles, the boundary layer, inviscid flow, vorticity dynamics, wave motion.

509. DYNAMIC OF IDEAL FLUIDS (3) Irrotational flow theory, two-dimensional and axisymmetric flows, airfoil theory, complex variables, unsteady phenomena; flow with vorticity, finite wing theory. Prerequisite: Aersp. 508.
510. COMPRESSIBLE FLOW (3) Classification and solution of compressible flow problems, high-speed gasdynamics, unsteady motion, transonic and hypersonic flows, atmospheric reentry.
511. AERODYNAMICALLY INDUCED NOISE (3) Review of fluid mechanics. General theory of aerodynamic sound. Noise radiation from jets, boundary layers, rotors, and fans. Structural response.
512. VISCOUS FLOW (3) Stress-deformation relations; Newtonian fluids, Navier-Stokes equations; exact, asymptotic laminar solutions; instability, transition; similitude and turbulent boundary layer.
514. STABILITY OF LAMINAR FLOWS (3) The stability of laminar motions in various geometries as influenced by boundary conditions and body forces of various kinds.
515. STATISTICAL THEORIES OF TURBULENCE (3) Statistical analysis of random scalar and vector fields. Homogeneous turbulence: similarity, correlation, and spectral descriptions; spectral transfer; production and dissipation.
517. INHOMOGENEOUS TURBULENCE (3) Flow instability and transition; descriptions of structural hypotheses and energy budgets for classical flows; closure models; role of turbulence measurements.
518. DYNAMICS AND CONTROL OF AEROSPACE VEHICLES (3) Dynamical problems of aircraft and missiles including launch, trajectory, optimization, orbiting, reentry, stability and control, and automatic control. Prerequisite: Aersp. 413 or 450.
526. (M.E. 526) COMPUTATIONAL METHODS FOR SHEAR LAYERS (3) Study of numerical solution methods for steady and unsteady laminar or turbulent boundary-layer equations in two and three dimensions. Prerequisite: Aersp. 423 or M.E. 540.
527. (M.E. 527) COMPUTATIONAL METHODS IN TRANSONIC FLOW (3) Numerical solution of partial differential equations of mixed type, with emphasis on transonic flows and separating boundary layers. Prerequisite: Aersp. 423 or M.E. 540.
529. ADVANCED ANALYSIS AND COMPUTATION OF TURBOMACHINERY FLOWS (3) Review of numerical methods; three-dimensional inviscid flow computation, two- and three-dimensional viscous flow effects and computation; recent advances. Prerequisites: Aersp. 423; Aersp. 507 or M.E. 418.
550. ASTRODYNAMICS (3) Applications of classical celestial mechanics to space flight planning. Determination and construction of orbital parameters by approximation methods. Perturbation techniques. Prerequisite: Aersp. 450 or Astro. 460 or E.Mch. 410 or Phys. 419.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## AGRICULTURAL ECONOMICS (AG EC)

JOHN W. MALONE, JR., *Head of the Department of Agricultural Economics and Rural Sociology*  
6 Weaver Building  
814-865-5461

**Degrees Conferred:** Ph.D., M.S., M.Agr.

### Senior Members of the Graduate Faculty

Donald J. Epp, Ph.D. (Michigan State) *Professor of Agricultural Economics*  
John C. Frey, Ph.D. (Iowa State) *Professor of Land Economics*  
Hays B. Gamble, Ph.D. (Penn State) *Professor of Agricultural Economics*  
Milton C. Hallberg, Ph.D. (Iowa State) *Professor of Agricultural Economics*  
Dale M. Heien, Ph.D. (George Washington) *Associate Professor of Agricultural Economics*  
Robert O. Herrmann, Ph.D. (Michigan State) *Professor of Agricultural Economics*  
Robert F. Hutton, Ph.D. (Harvard) *Professor of Farm Management*  
J. Dean Jansma, Ph.D. (Oklahoma State) *Professor of Agricultural Economics*



J. Patrick Madden, Ph.D. (Iowa State) *Professor of Agricultural Economics*  
 John W. Malone, Jr., Ph.D. (Oklahoma State) *Professor of Agricultural Economics*  
 Robert H. McAlexander, Ph.D. (Iowa State) *Professor of Farm Management*  
 Earl J. Partenheimer, Ph.D. (Michigan State) *Professor of Agricultural Economics*  
 Wayne A. Schutjer, Ph.D. (Michigan State) *Professor of Agricultural Economics*  
 Anthony P. Stemberger, Ph.D. (North Carolina State) *Professor of Agricultural Economics*

## **Associate Members of the Graduate Faculty**

Theodore R. Alter, Ph.D. (Michigan State) *Associate Professor of Agricultural Economics*  
 James G. Beierlein, Ph.D. (Purdue) *Assistant Professor of Agricultural Economics*  
 Sam M. Cordes, Ph.D. (Washington State) *Assistant Professor of Agricultural Economics*  
 Virgil E. Crowley, Ph.D. (Missouri) *Professor of Farm Management Extension*  
 Arthur B. Daugherty, Ph.D. (Penn State) *Adjunct Assistant Professor of Agricultural Economics*  
 Samuel A. Dum, Ph.D. (Purdue) *Associate Professor of Farm Management Extension*  
 James W. Dunn, Ph.D. (Oklahoma State) *Assistant Professor of Agricultural Economics*  
 Theodore E. Fuller, Ph.D. (Penn State) *Adjunct Assistant Professor of Agricultural Economics*  
 Frank M. Goode, Ph.D. (Minnesota) *Associate Professor of Agricultural Economics*  
 Kenneth F. Harling, Ph.D. (Purdue) *Assistant Professor of Agricultural Economics*  
 William L. Henson, Ph.D. (Penn State) *Adjunct Assistant Professor of Agricultural Economics and Rural Sociology*  
 Blair J. Smith, Ph.D. (North Carolina State) *Associate Professor of Agricultural Economics*  
 Robert D. Weaver, Ph.D. (Wisconsin) *Assistant Professor of Agricultural Economics*  
 Carl E. Young, Ph.D. (George Peabody) *Assistant Professor of Human Development*

The graduate program emphasizes economic theory and analytical techniques in the fields of farm management, production economics, agricultural marketing, resource economics, rural development, agricultural policy and prices, and international agricultural trade and development.

## **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Students entering the master's program should have a total of 9 credits in agricultural economics and/or economics. Students entering the doctoral program should have successfully completed courses in intermediate micro- and macroeconomic theory, in differential and integral calculus and linear algebra, and in introductory statistics. Students are permitted to enter the master's and doctoral programs with deficiencies but must pass courses to eliminate deficiencies as soon as possible.

Students with a 2.75 junior-senior grade-point average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.75 grade-point average may be made for students with special backgrounds, abilities, and interests.

## **Doctoral Degree Requirements**

There is no foreign language requirement for the Ph.D. degree; rather, the student must satisfactorily complete courses in economic theory and quantitative methods.

## **Other Relevant Information**

Students in this program may elect the dual-title degree program option in Operations Research for the Ph.D. and M.S. degrees (see p. 285).

Students may qualify for admission to the program in population issues consisting of interdisciplinary course work, with special emphasis on the economic, social, and geographic issues arising from the dynamics of population change.

## **Student Aids**

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

**AGRICULTURAL ECONOMICS (AG EC)**

401. LAND AND WATER RESOURCE POLICY (3) *Epp*
402. LAND AND WATER RESOURCE ECONOMICS (3) *Shortle*
403. RURAL COMMUNITY DEVELOPMENT (3) *Cordes*
407. FARM PLANNING AND FINANCIAL MANAGEMENT (3)
410. AGRICULTURAL REAL ESTATE APPRAISAL (3) *Gingrich*
420. AGRICULTURAL PRICES (3) *Stemberger*
450. AGRICULTURE AND INTERNATIONAL ECONOMIC DEVELOPMENT (3)
460. ECONOMICS OF THE FOOD INDUSTRY (3)
461. MANAGERIAL ECONOMICS IN AGRICULTURAL BUSINESS FIRMS (3)
462. ECONOMICS OF PUBLIC POLICY IN AGRICULTURE (3)
495. INTERNSHIP IN AGRIBUSINESS AND RURAL DEVELOPMENT (10)
496. INDEPENDENT STUDIES (1-18)
497. SPECIAL TOPICS (1-9)
  
501. MICROECONOMIC DECISION MAKING IN AGRICULTURE (3) Application of microeconomic theory to problems and decisions of farm households and agricultural firms. Prerequisite: Econ. 490 or 502 or Stat. 462. *Madden*
502. ECONOMICS OF NATURAL RESOURCES AND RURAL DEVELOPMENT (3) Emphasis will be placed on the application of economic concepts to problems and policies in rural areas. Prerequisites: Econ. 502, 503. *Goode*
503. ECONOMIC PERFORMANCE OF FOOD AND AGRICULTURAL MARKETING (3) Economic analysis of food marketing firms and institutions; identification and measurement of dimensions of market performance; public policy. Prerequisite: Econ. 502. *Dunn*
510. (Econ. 510) ECONOMETRICS I (3) General linear model, multicollinearity, specification error, autocorrelation, heteroskedasticity, restricted least squares, functional form, dummy variables, limited dependent variables. Prerequisite: Econ. 490 or Stat. 462 or 501. *Dunn*
511. (Econ. 511) ECONOMETRICS II (3) Stochastic regressors, distributed lag models, pooling cross-section and time-series data, simultaneous equation models. Prerequisite: Ag.Ec. (Econ.) 510. *Weaver*
517. RESOURCE ECONOMICS AND RURAL DEVELOPMENT (3) Present, apply, and empirically implement the concepts used for analyzing resource and rural development problems. Prerequisites: Econ. 502, 503. *Goode*
518. PROCESS OF RURAL POLICY DEVELOPMENT (3) Study of the concepts and applications of the process by which public policy evolves. Prerequisites: Econ. 502, 503.
519. ECONOMIC ANALYSIS OF LAND AND WATER RESOURCE POLICY (3) History and analysis of natural resource policies, including U.S. public land disposal, conservation, and environmental protection policies. Selected current topics. Prerequisites: Econ. 502, Ag.Ec. 517, 518.
525. RESEARCH METHODS IN RURAL SOCIAL SCIENCES (3) Scientific method in planning and conducting research. Prerequisites: 9 credits in social sciences.
527. QUANTITATIVE METHODS I\* (3) Quantitative techniques applied to agricultural economic issues. Prerequisite: Econ. 502. *Partenheimer*
528. QUANTITATIVE METHODS II (3) Advanced topics in quantitative techniques applied to agricultural economic issues. Prerequisite: Ag.Ec. 527.
534. DECISION MAKING IN THE FARM AND AGRIBUSINESS FIRM (3) Analysis of firm-level production problems, static and dynamic; single- and multiple-period decision models under certainty and uncertainty. Prerequisites: Econ. 502, 521, Ag.Ec. 511, 527. *Grisley*
536. AGRICULTURAL COMMODITY MARKETS (3) Specification, identification, and estimation of models for use in the evaluation and control of agricultural market behavior. Prerequisite: Ag.Ec. (Econ.) 510 or 511 or Econ. 521.
538. POLICY FOR THE FOOD AND AGRICULTURE SECTOR (3) Policy formation; policies for food and agriculture, consequences for farmers, consumers, resources; farm program benefits and costs; current issues. Prerequisites: Ag.Ec. (Econ.) 511, Econ. 521, 522. *Hallberg*



542. **LAND AND WATER RESOURCE ECONOMICS (3)** Selected topics to expand understanding of major economic concepts used in analysis of current natural resource problems. Prerequisites: Ag.Ec. 511, 517, Econ. 521; Ag.Ec. 401 or 402 or 502.
543. **RURAL ECONOMIC DEVELOPMENT THEORIES (3)** Discussion of the state-of-the-art in rural economic development research. Prerequisites: Ag.Ec. 517, 518, Econ. 521, 522.
595. (Econ. 595) **SEMINAR IN ECONOMETRIC THEORY (3)** Theories and methods relevant to the application of statistical methods to economics. Prerequisite: Ag.Ec. (Econ.) 510.
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**
602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)**

## AGRICULTURAL EDUCATION (AG ED)

SAMUEL M. CURTIS, *Head of the Department*  
102 Armsby Building  
814-865-1688

**Degrees Conferred:** Ph.D., D.Ed., M.S., M.Ed.

### Senior Members of the Graduate Faculty

Samuel M. Curtis, D.Ed. (Penn State) *Professor of Agricultural Education*  
Anne L. Heinsohn, Ph.D. (Penn State) *Associate Professor of Extension Education*  
Gene M. Love, Ph.D. (Penn State) *Professor of Agricultural Education*  
Richard F. Stinson, Ph.D. (Ohio State) *Professor of Agricultural Education and Horticulture*

### Associate Members of the Graduate Faculty

William I. Lindley, Ph.D. (Cornell) *Assistant Professor of Agricultural Extension Education*  
James H. Mortensen, Ph.D. (Penn State) *Associate Professor of Agricultural Education*  
Raymond H. Morton, Ph.D. (Ohio State) *Assistant Professor of Agricultural Education*  
Dennis C. Scanlon, Ph.D. (Ohio State) *Assistant Professor of Agricultural Education*  
William Williams, Ph.D. (Penn State) *Associate Professor of Agricultural Education*  
Edgar P. Yoder, Ph.D. (Ohio State) *Assistant Professor of Agricultural Education*

Graduate programs emphasize the professional improvement of teachers and agricultural and home economics extension personnel with education responsibilities. They provide advanced preparation for employment in administration, supervision, teaching (including teacher education), and research in agricultural education and related fields. A minor may be taken in an area of agricultural science or technology, or in general studies. Programs may include courses needed for certification in other fields of education.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Prerequisite for admission to a master's program is a minimum of 18 credits in professional education courses — including educational psychology and student teaching — or certification as a teacher of agriculture or equivalent professional experience. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission to the M.S. or M.Ed. program. Admission to a doctoral program requires a 3.00 grade-point average for graduate work. Applicants to the doctoral program must submit evidence of ability to write a scholarly paper or thesis and demonstrate a teaching-level competence in English. The best-qualified applicants for all degrees will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum grade-point averages may be made for students with special backgrounds, abilities, and interests. Applicants for the master's degree must submit an essay, two or three typewritten pages in

## AGRICULTURAL EDUCATION

length, that describes their background, work experience, education, and career goals in pursuing a master's degree.

### Master's Degree Requirements

A contractual agreement between adviser and student, including planned course work and time frame, must be completed before beginning the second semester of study. Successful performance on a four-hour written essay exam, plus a one-hour oral exam, is required of all M.S. and M.Ed. candidates near the completion of their course work for the degree. The master's candidate also is required to successfully complete an oral defense of a paper or thesis.

A minimum of two years of successful public, private, or extension teaching experience is required before the master's or doctoral degree is completed.

### Doctoral Degree Requirements

There are no foreign language requirements for the Ph.D. in Agricultural Education; however, Engl. 418 and Sp.Com. 312, or equivalent communication courses, are required.

A minimum of two years of successful public, private, or extension teaching experience is required before the master's or doctoral degree is completed.

### Other Relevant Information

Selection and appointment of a thesis adviser and doctoral committee follow admission to candidacy. The candidate consults the department head in selecting an adviser. The candidate, in cooperation with an adviser, selects the doctoral committee. The chairman of the committee is not necessarily the thesis adviser, but the thesis adviser is a member of the committee.

### Student Aids

Graduate assistantships available through this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## AGRICULTURAL EDUCATION (AG ED)

- 400v. EDUCATIONAL PROGRAMS IN AGRICULTURE FOR DEVELOPING COUNTRIES (3)
- 412. METHODS OF TEACHING AGRICULTURE (3)
- 413. INSTRUCTIONAL MANAGEMENT IN AGRICULTURAL MECHANICS (2)
- 418v. SURVEY OF VOCATIONAL EDUCATION IN AGRICULTURE (1-4)
- 420v. INSTRUCTIONAL MEDIA IN AGRICULTURE (1-6)
- 424v. OCCUPATIONAL GUIDANCE IN AGRICULTURAL INDUSTRY (1-4)
- 426v. ADULT EDUCATION IN AGRICULTURE (1-4)
- 434v. AGRICULTURAL DEVELOPMENTS (1-6)
- 440. COMMUNICATION METHODS AND MEDIA IN AGRICULTURE (3)
- 450. METHODOLOGY OF EXTENSION EDUCATION (3)
- 490, 490v. COLLOQUIUM (1-3)
- 495v. STUDENT TEACHING IN AGRICULTURE (8)
- 496, 496v. INDEPENDENT STUDIES (1-8)
- 497, 497v. SPECIAL TOPICS (1-9)

501v. AGRICULTURAL EDUCATION IN THE UNITED STATES (1-3) Historical development, social and philosophical foundations, and current status in relation to the total vocational-technical education program.

502v. TEACHING AGRICULTURE (1-3) Vocational education objectives, learning theory, class instruction, cooperative occupational experience, and evaluation.

507. ADMINISTRATION AND SUPERVISION OF AGRICULTURAL EDUCATION I (1-2) Basics of vocational funding, supervision, leadership, and management for agricultural education. Prerequisite: previous experience in agricultural education or vocational education.

508v. ADMINISTRATION AND SUPERVISION OF AGRICULTURAL EDUCATION II (1-2) Basics of vocational funding, supervision, leadership, and management for agricultural education.

509v. TEACHER EDUCATION IN AGRICULTURE (1-6) Organization and administration of university programs of teacher education in agriculture, including preservice preparation, continuing education, research, and other services.



520v. **SCIENTIFIC METHOD IN THE STUDY OF AGRICULTURAL EDUCATION (1-4)** Methods of procedure in investigation and experimentation in education, accompanied by a critical examination of studies made in agricultural education.

521v. **SCIENTIFIC METHOD IN THE STUDY OF AGRICULTURAL EDUCATION (1-4)** Continuation of Ag.Ed. 520v; emphasis upon statistical techniques for students' individual problems.

524v. **PROGRAM DEVELOPMENT IN AGRICULTURAL EDUCATION (1-3)** Analysis of occupational needs of students and employment prospects; organization of courses of study and other activities of teachers.

530. **AGRICULTURAL COLLEGE TEACHING (3)** Selection and organization of subject matter for specific courses, methods of learning, teaching devices, techniques of teaching, and measurement of results of teaching.

590, 590v. **COLLOQUIUM (1-3)**

596, 596v. **INDIVIDUAL STUDIES (1-9)**

597, 597v. **SPECIAL TOPICS (1-9)**

## AGRICULTURAL ENGINEERING (AG E)

HAROLD V. WALTON, *Head of the Department*  
250 Agricultural Engineering Building  
814-865-7792

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Albert R. Jarrett, Ph.D. (Penn State), P.E. *Associate Professor of Agricultural Engineering*  
Harvey B. Manbeck, Ph.D. (Oklahoma State), P.E. *Professor of Agricultural Engineering*  
Charles T. Morrow, Ph.D. (Penn State), P.E. *Associate Professor of Agricultural Engineering*  
Sverker P. E. Persson, Ph.D. (Michigan State) *Professor of Agricultural Engineering*  
Kermit Q. Stephenson, M.S. (Arkansas), P.E. *Professor of Agricultural Engineering*  
Paul N. Walker, Ph.D. (Massachusetts), P.E. *Associate Professor of Agricultural Engineering*  
Harold V. Walton, Ph.D. (Purdue), P.E. *Professor of Agricultural Engineering*

### Associate Members of the Graduate Faculty

David E. Brune, Ph.D. (Missouri) *Assistant Professor of Agricultural Engineering*  
Donald R. Daum, M.S. (Penn State), P.E. *Professor of Agricultural Engineering*  
James W. Hilton, Ph.D. (Iowa State) *Assistant Professor of Agricultural Engineering*  
James R. Hoover, Ph.D. (South Dakota State), P.E. *Adjunct Assistant Professor of Agricultural Engineering*  
William L. Kjelgaard, M.S. (Penn State), P.E. *Associate Professor of Agricultural Engineering*  
Dennis J. Murphy, Ph.D. (Penn State) *Assistant Professor of Agricultural Engineering*  
Sudhir K. Sastry, Ph.D. (Florida) *Assistant Professor of Agricultural Engineering*  
Morris E. Schroeder, Ph.D. (Purdue) *Professor of Agricultural Engineering*  
Mark D. Shaw, M.S. (Penn State), P.E. *Associate Professor of Agricultural Engineering*

Graduate programs are available in the areas of the physical properties of biomaterials, protected plant and animal production, food engineering including freezing and thermal processing, agricultural structures, agricultural byproduct utilization, agricultural systems engineering, biomass energy conservation, alternative energy sources, agronomic crop mechanization, forage and animal interaction, horticultural engineering, microclimate modification, soil dynamics, infiltration, drainage, and irrigation.

Excellent facilities, including equipment and instrumentation, are available for research in the designated areas. Among the special facilities are controlled environmental chambers; a waste and pollutants evaluation facility; plant growth structures for modified atmosphere; a general purpose analog computer; a microcomputer laboratory; data-processing systems, including interactive access to University computer facilities; and laboratories for research on physical properties of agricultural materials. Special equipment is available for physical properties work, including testing machines complete with environmental chambers and data acquisition systems, a polariscope for photoelastic stress analysis, triaxial testing equipment, and other unique and specially designed testing facilities.

Equipment is also available for studying thermal properties of food materials. Special facilities outside the Agricultural Engineering Building include a mushroom research and demonstration facility and a 1,500-acre agricultural research center for cooperative work with agronomic and horticultural production systems.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. A student may be admitted provisionally for graduate study in the program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

An undergraduate major in engineering is normally a prerequisite to major work.

Students without an undergraduate engineering degree will be considered for admission on a provisional basis pending the completion of a number of additional credits to be specified on an individual basis. These remedial courses must be completed with a minimum grade-point average of 2.75. The best-qualified applicants will be accepted up to the number of spaces that are available for new students.

### Master's Degree Requirements

All candidates for the M.S. degree must prepare a thesis. In addition, 30 credits of course work are required. Each program should include at least one course from the areas of agricultural or biological science, mathematics, and statistics. All students are expected to attend announced departmental seminars. Additional program details are contained in a syllabus available from the department.

### Doctoral Degree Requirements

The communications and foreign language requirement for the Ph.D. degree may be satisfied by either 9 credits of courses in an approved sequence or a foreign language. Prior approval by the Ph.D. Advisory Committee must be obtained to study a foreign language other than French, German, Russian, or Spanish.

All students should complete a master's program before pursuing the doctoral degree.

A graduate student who wishes to become a doctoral candidate must be approved for candidacy by the Graduate Studies Committee of the agricultural engineering department. No specified number of courses completed or credits earned are required by the department, except that the candidate who has completed the M.S. degree must take at least 9 credits of course work and 2 credits of colloquium in the agricultural engineering department. All students are expected to attend announced departmental seminars. A doctoral committee appointed by the Graduate School will approve the student's course work program. Typical programs of study may be found in a syllabus available from the department.

### Student Aids

Graduate assistantships available through the program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## AGRICULTURAL ENGINEERING (AG E)

- 401. FARM MECHANICS FOR TEACHERS OF VOCATIONAL AGRICULTURE (1½-9)
- 418. MICROCOMPUTERS IN AGRICULTURE (2)
- 420. SEMINAR (1)
- 425. PHYSICAL PROCESSES IN FOOD MANUFACTURING (3)
- 428. ELECTRIC POWER AND INSTRUMENTATION IN AGRICULTURE (3)
- 429. FARM MACHINERY MANAGEMENT (3)
- 432. PRINCIPLES OF AGRICULTURAL BUILDINGS (3)
- 434. PRINCIPLES AND DESIGN OF FARM TRACTORS AND MACHINES (3)
- 435. PRINCIPLES OF AGRICULTURAL PROCESSING (3)
- 437. PRINCIPLES OF SOIL-WATER ENGINEERING (3)
- 438. AGRICULTURAL MEASUREMENTS AND CONTROL SYSTEMS (3)
- 453. MECHANICAL PROPERTIES OF AGRICULTURAL MATERIALS (3)
- 457. LAND WASTE DISPOSAL (3)
- 460. POWER SOURCES FOR AGRICULTURE (3)
- 461. HYDRAULIC POWER IN AGRICULTURAL EQUIPMENT (3)
- 462. FUNCTIONAL DESIGN OF AGRICULTURAL STRUCTURES (3)



- 464. DESIGN OF AGRICULTURAL MACHINES (3)
  - 465. THERMAL, OPTICAL, AND ELECTRICAL PROPERTIES OF AGRICULTURAL MATERIALS (3)
  - 467. IRRIGATION SYSTEMS DESIGN (3)
  - 469. OPTIMIZATION OF AGRICULTURAL SYSTEMS AND ENERGY UTILIZATION (3)
  - 488. INTRODUCTION TO AGRICULTURAL ENGINEERING DESIGN (1)
  - 489. AGRICULTURAL ENGINEERING DESIGN PROBLEM (1-3)
  - 490. AGRICULTURAL MECHANIZATION SEMINAR (1)
  - 495. AGRICULTURAL ENGINEERING INTERNSHIP (1-6)
  - 496. INDEPENDENT STUDIES (1-18)
  - 497. SPECIAL TOPICS (1-9)
- 
- 503. PHYSICAL PROPERTIES OF PLANT AND ANIMAL PRODUCTS (3) Physical characteristics; mechanical, rheological, thermal, electrical, and optical properties in relation to handling, storage, processing, and quality evaluation.
  - 505. EXPERIMENTAL AND APPLIED INSTRUMENTATION (4) The theory and application of electronics for instrumentation and experimental research.
  - 510. THEORY OF SOIL-MACHINE INTERACTION (3) Performance of agricultural and earth-moving machines and off-road vehicles related to soil stress and strain in contact region. Prerequisite: Ag.E. 434 or C.E. 244 or M.E. 50.
  - 511. THEORY AND DESIGN OF AGRICULTURAL MACHINE COMPONENTS (3) Functional analysis of machine components for cutting, compressing, threshing, sorting, metering, and transporting agricultural products and materials. Prerequisite: Ag.E. 434 or M.E. 50.
  - 512. STRUCTURAL AND ENVIRONMENTAL ANALYSIS OF AGRICULTURAL BUILDINGS (3) Advanced topics on the design and analysis of structural and environmental control systems for agricultural buildings. Prerequisites: Ag.E. 432, 462.
  - 515. THERMAL PHENOMENA IN FOOD ENGINEERING (3) Heat and mass transfer phenomena, nutrient degradation rates, and energy use in food processing.
  - 519. CONTROL OF AGRICULTURAL PROCESSES USING MICROCOMPUTERS (1-3) Design and application of control systems for agricultural processes and equipment using microcomputers. Prerequisite: Ag.E. 418.
  - 590. COLLOQUIUM (1-3)
  - 596. INDIVIDUAL STUDIES (1-9)
  - 597. SPECIAL TOPICS (1-9)
  - 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## AGRICULTURAL MECHANIZATION (AG M)

HAROLD V. WALTON, *Head of the Department of Agricultural Engineering*  
 250 Agricultural Engineering Building  
 814-865-7792

**Degree Conferred:** M.Agr.

### Senior Members of the Graduate Faculty

Albert R. Jarrett, Ph.D. (Penn State), P.E. *Associate Professor of Agricultural Engineering*  
 Harvey B. Manbeck, Ph.D. (Oklahoma State), P.E. *Professor of Agricultural Engineering*  
 Charles T. Morrow, Ph.D. (Penn State), P.E. *Associate Professor of Agricultural Engineering*  
 Sverker P.E. Persson, Ph.D. (Michigan State) *Professor of Agricultural Engineering*  
 Kermit Q. Stephenson, M.S. (Arkansas), P.E. *Professor of Agricultural Engineering*  
 Paul N. Walker, Ph.D. (Massachusetts), P.E. *Associate Professor of Agricultural Engineering*  
 Harold V. Walton, Ph.D. (Purdue), P.E. *Professor of Agricultural Engineering*.

### Associate Members of the Graduate Faculty

David E. Brune, Ph.D. (Missouri) *Assistant Professor of Agricultural Engineering*  
 Donald R. Daum, M.S. (Penn State), P.E. *Professor of Agricultural Engineering*  
 James W. Hilton, Ph.D. (Iowa State) *Assistant Professor of Agricultural Engineering*

## AGRONOMY

James R. Hoover, Ph.D. (South Dakota State), P.E. *Adjunct Assistant Professor of Agricultural Engineering*

William L. Kjelgaard, M.S. (Penn State), P.E. *Associate Professor of Agricultural Engineering*

Dennis J. Murphy, Ph.D. (Penn State) *Assistant Professor of Agricultural Engineering*

Sudhir K. Sastry, Ph.D. (Florida) *Assistant Professor of Agricultural Engineering*

Morris E. Schroeder, Ph.D. (Purdue) *Professor of Agricultural Engineering*

Mark D. Shaw, M.S. (Penn State), P.E. *Associate Professor of Agricultural Engineering*

This program is designed to provide opportunities to help individuals aid the agricultural industry to cope more successfully with rapidly changing technology and the challenges to increase food production with greater efficiency in the use of energy and other production inputs. The Master of Agriculture is a professional degree providing opportunities for students to increase their knowledge and competencies in the various phases of agricultural mechanization. Specific graduate program emphases are available in fields such as soil and water management, crop production, animal science, and agricultural equipment. Special facilities available to students are described under the Agricultural Engineering graduate program listing in the Graduate Bulletin.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. A student may be admitted provisionally for graduate study in the program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Specific admission requirements include an undergraduate degree in agriculture or a related area and mathematics through Math. 110 or 140, or equivalent course work. The best-qualified applicants will be accepted up to the number of spaces available for new students.

### Master's Degree Requirements

The following specific requirements are in addition to those specified for the M. Agr. degree: Ag. 400 or an equivalent course or background in statistics; Cmp.Sc. 402 or an equivalent course or background in computer science; 12 credits in Ag.E. courses, including Ag.E. 596 and the preparation of a paper or Ag.E. 495 (3 credits); Ag.E. 590 and the presentation of a paper; 6 credits in agricultural science or production courses; and additional courses for a total of 30 graduate credits.

### Student Aids

Graduate assistantships normally are not available to students enrolled in this program. Other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## AGRONOMY (AGRO)

JAMES L. STARLING, *Head of the Department*

117 Tyson Building

814-865-6541

**Degrees Conferred:** Ph.D., M.S., M.Agr.

### Senior Members of the Graduate Faculty

Dale E. Baker, Ph.D. (Missouri) *Professor of Soil Chemistry*

Jean-Marc Bollag, Ph.D. (Basel) *Professor of Soil Microbiology*

Edward J. Cielkosz, Ph.D. (Wisconsin) *Professor of Soil Genesis and Morphology*

Richard W. Cleveland, Ph.D. (California) *Professor of Plant Breeding*

Robert L. Cunningham, Ph.D. (Washington State) *Professor of Soil Genesis and Morphology*

Joseph M. Duich, Ph.D. (Penn State) *Professor of Turfgrass Science*

Richard H. Fox, Ph.D. (Arizona) *Associate Professor of Soil Science*

Daniel D. Fritton, Ph.D. (Iowa State) *Professor of Soil Physics*

Jon K. Hall, Ph.D. (Penn State) *Associate Professor of Soil Chemistry*

Joseph D. Harrington, Ph.D. (Penn State) *Professor of Agronomy*

Richard R. Hill, Jr., Ph.D. (Cornell) *Adjunct Professor of Plant Breeding*

Leon J. Johnson, Ph.D. (Penn State) *Professor of Soil Mineralogy*

Melvin W. Johnson, Ph.D. (Wisconsin) *Associate Professor of Plant Breeding*

Gerald A. Jung, Ph.D. (Wisconsin) *Adjunct Professor of Agronomy*



William A. Kendall, Ph.D. (Ohio State) *Adjunct Professor of Crop Physiology*  
 Daniel P. Knievel, Ph.D. (Wisconsin) *Associate Professor of Crop Physiology*  
 Harold G. Marshall, Ph.D. (Minnesota) *Adjunct Professor of Plant Breeding*  
 Guy W. McKee, Ph.D. (Penn State) *Professor of Agronomy*  
 Gary W. Petersen, Ph.D. (Wisconsin) *Professor of Soil Genesis and Morphology*  
 Harry B. Pionke, Ph.D. (Wisconsin) *Adjunct Professor of Soil Science*  
 Marvin L. Risius, Ph.D. (Cornell) *Professor of Plant Breeding*  
 Andrew S. Rogowski, Ph.D. (Iowa State) *Adjunct Professor of Soil Physics*  
 John S. Shenk, Ph.D. (Michigan State) *Professor of Plant Breeding*  
 James L. Starling, Ph.D. (Penn State) *Professor of Agronomy*  
 William C. Templeton, Jr., Ph.D. (Purdue) *Adjunct Professor of Agronomy*  
 Donald V. Waddington, Ph.D. (Massachusetts) *Professor of Soil Science*  
 Thomas L. Watschke, Ph.D. (Virginia Polytechnic) *Professor of Turfgrass Science*

#### **Associate Members of the Graduate Faculty**

John E. Baylor, Ph.D. (Penn State) *Professor of Agronomy Extension*  
 Clyde C. Berg, Ph.D. (Washington State) *Adjunct Associate Professor of Agronomy*  
 David L. Gustine, Ph.D. (Michigan State) *Adjunct Associate Professor of Crop Physiology*  
 Nathan L. Hartwig, Ph.D. (Wisconsin) *Associate Professor of Weed Science*  
 O. Elwood Hatley, Ph.D. (Purdue) *Associate Professor of Agronomy Extension*  
 Les E. Lanyon, Ph.D. (Ohio State) *Assistant Professor of Soil Fertility*  
 Joseph H. McGahen, Ph.D. (Penn State) *Professor of Agronomy Extension*  
 Roger Pennock, Ph.D. (Michigan State) *Associate Professor of Soil Genesis and Morphology*  
 Ronald R. Schnabel, Ph.D. (Washington State) *Adjunct Assistant Professor of Soil Science*  
 Raymond F. Shipp, Ph.D. (Penn State) *Associate Professor Agronomy Extension*  
 William L. Stout, Ph.D. (Penn State) *Adjunct Assistant Professor of Soil Science*  
 William C. Stringer, Ph.D. (Virginia Polytechnic) *Assistant Professor of Crop Management*

Agronomy graduate programs emphasize research that increases the efficiency of production of agro-nomic crops, improves the quality of food, feed, and fiber available for man and animal, assists in the use and development of land resources, develops an understanding of the basic soil-plant-animal-climate complex of which man is a part, and improves the overall quality of the human environment. Within this framework, students may specialize in soil science, crop science, or soil and crop management, including turfgrass management. Areas of specialization in soil science include chemistry, fertility, genesis and morphology, microbiology, mineralogy, and physics. Crop science specialties include breeding and genetics, ecology and management, physiology, and weed science.

Research facilities include a 340-acre experimental farm with irrigation facilities, a 22-acre turf-grass research center, greenhouses, service areas, and a number of well-equipped experimental laboratories. The department enjoys close collaboration with three U.S.D.A. research units — the Northeast Pasture Research Laboratory, the Northeast Watershed Research Center, and a small grains research unit, which add substantial strength to the research and graduate education capabilities of the department.

#### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in the program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Prerequisites for major work in agronomy vary with the area of specialization and the degree sought, but courses in chemistry, mathematics, physics, geology, basic and applied biological sciences, and English communication skills are required. Applicants for the M.S. degree should have a baccalaureate degree including 76 credits of basic and applied natural sciences. For the M.Agr. degree program, an applicant must present a baccalaureate degree in agricultural or forest science.

A minimum junior-senior grade-point average of 3.00 is required for admission to the Agronomy master's degree programs. In addition, a grade-point average of 3.00 is required in all courses in the biological and physical sciences regardless of when taken. Exceptions to these requirements may be made for students with special backgrounds, abilities, and interests.

Admission to the Ph.D. program requires an M.S. or equivalent degree, and 100 credits (including credits of the baccalaureate degree) of basic and applied natural sciences. Applicants for the Ph.D. program will be evaluated on the quality of work completed in all previous degree programs.

Students who lack some of the prerequisite courses may be admitted but are required to take these courses without degree credit. The best-qualified applicants will be accepted up to the number of spaces available for new students.

### Master's Degree Requirements

In addition to the general requirements for the M.S. degree as defined by the Graduate School, the department requires 6 credits of 400- or 500-level formal courses in a minor or general studies area. Participation in at least one Agronomy seminar course each semester is required, and students must register for at least 1 credit for an Agronomy seminar. An advisory committee will be appointed for each student, and additional courses and requirements may be determined by this advisory committee.

A thesis based on field and/or laboratory research is required for the M.S. degree. Candidates for the M.Agr. degree may prepare a paper in lieu of a thesis which is based on library research.

Both M.S. and M.Agr. candidates must pass a final examination.

### Doctoral Degree Requirements

Beyond the general requirements for the Ph.D. defined by the Graduate School, the department has a number of specific requirements regarding course level and distribution which are defined in the departmental publication, "Graduate Degrees in Agronomy." While a minimum number of courses for the degree is not specified, the doctoral advisory committee has the responsibility to specify courses and credits essential for the education and development of the candidate. Students are expected to be educated in depth in a specific subfield of agronomy and to have a perspective of the general field. Normally, 55 to 60 credits in formal course work beyond the B.S. degree are required. Doctoral candidates are required to participate regularly in a departmental seminar and to register for at least 2 credits of the seminar during the Ph.D. program.

The communication and foreign language requirement for the Ph.D. degree may be met either by demonstrating a knowledge of at least one foreign language or by completing at least 6 credits of course work in an area of English communications approved by the student's advisory committee.

In addition to the candidacy, comprehensive, and final oral examinations, the department requires a competency examination to be taken after a student passes the candidacy. The purpose of this examination is to determine the student's strengths and weaknesses in pertinent subject matter and to assist the committee in providing direction relative to required course work.

### Other Relevant Information

Every student has a close professional relationship with his or her faculty adviser. While research which is done for the thesis will be on subjects that fall within the ongoing research program of the adviser, students are encouraged to propose research projects that are of interest to them. For the most part, all costs relative to the research program will be covered by the department. The department encourages professional development of students through participation in meetings of relevant professional societies and organizations.

### Student Aids

Graduate research and teaching assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## AGRONOMY (AGRO)

- 401. SOIL COMPOSITION AND PHYSICAL PROPERTIES (3) *Fritton and Johnson*
- 402. CHEMISTRY OF SOILS AND FERTILIZERS (3) *Fox*
- 410. CROP SCIENCE (3) *Knievel*
- 411. BREEDING OF FIELD CROPS (3) *Cleveland*
- 415. SOIL MORPHOLOGY, MAPPING, AND LAND USE (3) *Petersen*
- 416. SOIL GENESIS AND CLASSIFICATION (3) *Ciolkosz*
- 419. SOIL PROPERTIES (4) *Baker*
- 420. AGRONOMIC CASE STUDIES IN SOIL, PLANT, AND WATER MANAGEMENT (3) *Lanyon*
- 422. CONSERVATION OF SOIL AND WATER RESOURCES (3) *Cunningham*
- 423. FORAGE CROP MANAGEMENT (3) *Stringer*
- 425. FIELD CROP MANAGEMENT (3) *Hatley*
- 436. ADVANCED TURFGRASS MANAGEMENT (2) *Waddington*
- 438. PRINCIPLES OF WEED CONTROL AND HERBICIDE PROPERTIES (5) *Hartwig*
- 490. AGRONOMY COLLOQUIUM (1)



495. INTERNSHIP (1-5)
  496. INDEPENDENT STUDIES (1-18)
  497. SPECIAL TOPICS (1-9)
- 
501. SOIL FERTILITY (3) Soil-plant relations emphasizing recent concepts of ion accumulation by plants as affected by soil conditions and plant physiology. Prerequisites: Agro. 402, Biol. 441. *Hall*
  506. SOIL PHYSICAL CHEMISTRY (4) Colloidal chemistry of soils emphasizing ion adsorption, double-layer theory, diffusion, and water properties. Prerequisites: Agro. 419; Bioch. 425 or Chem. 451. *Baker*
  507. SOIL PHYSICS (3-4) Soil physical properties emphasizing water, heat, gas, and ion movement in unsaturated soils. Laboratory included with 4 credits. Prerequisites: 6 credits each of calculus, physics, and soils. *Fritton*
  509. METHODS OF GENETIC ANALYSIS (3) Methods of qualitative genetics. Tests of hypotheses, homogeneity, linkage detection, calculations of recombination values, monosomic analysis, and tetrasomic inheritance. Prerequisites: 6 credits of genetics or plant breeding. *Cleveland*
  510. CYTOGENETICS IN PLANT BREEDING (3) Chromosomal heredity of agricultural plants. Chromosome morphology; cytogenetic behavior of aneuploids, haploids, auto- and allopolyploids, and interspecific hybrids. Prerequisites: 6 credits of genetics, including 3 credits of cytogenetics or cytology. *Cleveland*
  511. BIOMETRICAL PLANT BREEDING (3) Quantitative genetics of plant populations; applications to breeding methodology and selection. Prerequisites: Agro. 512; 3 credits in plant breeding. *Hill and Risius*
  512. FIELD PLOT TECHNIQUE (4) Ramifications of analysis of variance techniques; combining and analyzing data from several experiments; selection of valid error terms. Prerequisite: Ag. 400 or Stat. 200. *Risius*
  515. NUTRITIVE VALUE OF CROP PLANTS (3) Biochemical, physiological, genetic, and morphological nature of crop plants related to animal response. Laboratory includes nutritive evaluation procedures. Prerequisites: 3 credits of crop production and 6 credits of biochemistry and/or nutrition. *Shenk*
  517. CROP ECOLOGY AND PHYSIOLOGY (3) Ecological and physiological factors affecting the productivity of crop plants. Prerequisite: Agro. 410. *Kniewel*
  518. RESPONSES OF CROP PLANTS TO ENVIRONMENTAL STRESS (3) Physiological and ecological aspects of the response of crop plants to environmental stresses in establishment, persistence, and reproduction. Prerequisite: Agro. 410. *McKee and Kniewel*
  519. NATURE OF SOIL MINERALS (3) Constituent minerals of soils: modern methods for identification; relations to soil formation and agricultural practices. Prerequisite: Agro. 401. *Johnson*
  545. THE APPLICATION OF STATISTICS TO FIELD EXPERIMENTS (4) Use of advanced experimental designs in planning, analyzing, and interpreting experiments; includes lattice designs, factorials, confounding, simple and multiple covariance techniques. Prerequisite: Agro. 512. *Risius and Shenk*
  590. COLLOQUIUM (1-3)
  596. INDIVIDUAL STUDIES (1-9)
  597. SPECIAL TOPICS (1-9)
  602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## AMERICAN STUDIES (AMSTD)

IRWIN RICHMAN, *Chairman, Graduate Program in American Studies*  
The Capitol Campus  
Middletown, PA 17057  
717-948-6196

**Degree Conferred:** M.A.

### Senior Members of the Graduate Faculty

Robert J. Graham, Ph.D. (Pennsylvania) *Associate Professor of Humanities and American Studies*  
Theodora R. Graham, Ph.D. (Pennsylvania) *Associate Professor of Humanities and English*  
Theodore L. Gross, Ph.D. (Columbia) *Professor of English*  
Irwin Richman, Ph.D. (Pennsylvania) *Professor of American Studies and History*  
Nancy M. Tischler, Ph.D. (Arkansas) *Professor of English and Humanities*  
George D. Wolf, Ph.D. (Pennsylvania) *Professor of American Studies and History*

### Associate Members of the Graduate Faculty

Michael L. Barton, Ph.D. (Pennsylvania) *Associate Professor of Social Science and American Studies*  
Simon J. Bronner, Ph.D. (Indiana) *Assistant Professor of Folklore and American Studies*  
Eton F. Churchill, M.F.A. (Tulane) *Assistant Professor of Humanities and Multi-Media Journalism*  
John S. Patterson, Ph.D. (Brown) *Associate Professor of American Studies and History*

This program emphasizes the study of American society as a whole, not as interpreted by a single discipline, but in the larger context of culture. The purpose of the program is to provide the student with the opportunity to acquire knowledge and understanding within any of the following areas: history, literature, media, museology, folklore, art, architecture, music, and the dynamics and interrelationships of various of these areas. While some students are full time, the majority are employed part-time students. All 500-level courses are offered in the evening. Every attempt is made to individualize the course of study for the specific student's need. Faculty research interests include American art, literature, material culture, Gettysburg, screenwriting, American character, and popular culture. There are strong ties with local educational and cultural institutions, including the William Penn Memorial Museum, Pennsylvania Farm Museum of Landis Valley, and the Dauphin County Historical Society.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

There are no course work prerequisites for admission to the master's program; however, a student must have received a baccalaureate degree from an accredited institution, earned under residence and credit conditions substantially equivalent to those required by The Pennsylvania State University. The application, transcripts, two letters of recommendation, and a letter outlining personal goals and reasons for applying for admission to the program should be sent to the Graduate Office, The Capitol Campus, Middletown PA 17057.

### Degree Requirements

The student is required to take a minimum of 30 credits, including at least 18 credits in the 500 series. An original scholarly master's paper or a creative project or a specialized examination is required for graduation. One to 6 credits in Am.Std. 580 can be earned during work on the master's project.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

**MUSEUM INTERNSHIPS** — Available to graduate students in American Studies at the Capitol Campus; stipend varies. Apply to Professor Irwin Richman, Chairman, Graduate Program in American Studies, Capitol Campus.



## REQUIRED COURSES

AM.STD. 500. THEORY AND METHODS (3) Introduction to graduate work in American Studies through exploration of the approaches, materials, and interpretation of the field.

AM.STD. 580. PROJECTS IN AMERICAN STUDIES (1-6) Independent exploration within American Studies; evidenced by major paper, film, exhibition, or specialized examination.

APPROPRIATE COURSES may be taken from the following list and from 500-level courses in other fields with the concurrence of the student's adviser.

AM.STD. 511. PIVOTAL BOOKS (3-9) Exploration of a number of books which have been particularly influential in shaping thinking about American civilization.

AM.STD. 530. TOPICS IN AMERICAN FOLKLORE (3) A detailed exploration of aspects of folklore and folklife in America.

AM.STD. 533. AMERICAN CIVILIZATION IN THE EIGHTEENTH CENTURY (3-9) Detailed investigation of specific topics in eighteenth-century American civilization.

AM.STD. 534. AMERICAN CIVILIZATION IN THE NINETEENTH CENTURY (3-9) Representative interdisciplinary investigation of social, historical, economic, and aesthetic forces predominant in nineteenth-century America.

AM.STD. 535. AMERICAN CIVILIZATION IN THE TWENTIETH CENTURY (3-9) Detailed investigation of specific periods or topics in twentieth-century American civilization.

AM.STD. 570. TOPICS IN AMERICAN ART (1-6) Various themes within the American arts will be explored under this rubric.

AM.STD. 575. MUSEUM INTERNSHIP (3) A supervised museum internship experience featuring a "hands-on" introduction into aspects of the curatorial profession. Prerequisite: permission of instructor.

AM.STD. 590. COLLOQUIUM (1-3)

AM.STD. 596. INDIVIDUAL STUDIES (1-9)

AM.STD. 597. SPECIAL TOPICS (1-9)

ADDITIONAL COURSES may be taken from the following list and from 400-level courses in other fields with the concurrence of the student's adviser.\*

AM.STD. 400. EARLY AMERICA, 1620-1828 (3)

AM.STD. 403. AMERICAN IDEAS (3)

AM.STD. 422. WESTWARD MOVEMENT (3)

AM.STD. 431. THE AMERICAN CHARACTER (3)

AM.STD. 442. AMERICAN FOLKLORE (3)

AM.STD. 451. CIVIL WAR AND RECONSTRUCTION (3)

AM.STD. 452. THE AMERICAN RENAISSANCE (3)

AM.STD. 453. INDUSTRIAL AMERICA (3)

AM.STD. 454. PARTIES AND POLITICS IN AMERICA (3)

AM.STD. 456. MASS CULTURE: THE POPULAR ARTS IN AMERICA (3)

AM.STD. 457. ETHNIC AMERICA (3)

AM.STD. 458. CONTEMPORARY AMERICA, 1945-PRESENT (3)

AM.STD. 459. AMERICA'S COMING OF AGE 1914-1939 (3)

AM.STD. 460. AMERICAN ART AND ARCHITECTURE (3)

AM.STD. 461. AMERICAN ART AND ARCHITECTURE OF THE NINETEENTH CENTURY (3)

AM.STD. 463. AMERICAN MUSIC (3)

AM.STD. 469. AMERICAN INDIAN ETHNOLOGY (3)

AM.STD. 470. REGIONALISM IN AMERICA (3)

AM.STD. 480. MUSEUMS AND CULTURE (3)

AM.STD. 491. SEMINAR IN AMERICAN CULTURE (3)

AM.STD. 496. INDEPENDENT STUDIES (1-18)

\*Descriptions of these courses may be found in *The Capitol Campus Bulletin*.

## ANATOMY

AM.STD. 497. SPECIAL TOPICS (1-9)

PUB.PL. 403. CONTEMPORARY U.S. FOREIGN POLICY (3)

PUB.PL. 470. THE PRESIDENCY AND THE EXECUTIVE PROCESS (3)

## ANATOMY (ANAT)

BRYCE L. MUNGER, *Chairman of the Department*  
The Milton S. Hershey Medical Center  
Hershey, PA 17033  
717-534-8650

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Alphonse E. Leure-duPree, Ph.D. (London) *Associate Professor of Anatomy*

Bryce L. Munger, M.D. (Washington) *Professor and Chairman of Anatomy*

Robert B. Page, M.D. (Columbia) *Associate Professor of Neurosurgery and Anatomy*

Ian S. Zagon, Ph.D. (Colorado) *Associate Professor of Anatomy*

### Associate Members of the Graduate Faculty

Pamela C. Colony, Ph.D. (Boston) *Assistant Professor of Anatomy*

Bang H. Hwang, Ph.D. (Iowa) *Assistant Professor of Anatomy*

Robert R. Kulikowski, Ph.D. (S.U.N.Y.) *Assistant Professor of Anatomy and Physiology*

The graduate program emphasizes the general areas of gross anatomy, histology/cytology, neuroanatomy/neurophysiology, or appropriate combinations of these areas. Approaches offered include morphological (descriptive, comparative, developmental), functional (physiological, chemical), and experimental.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

A bachelor's degree reflecting a reasonable background in zoology or biology, mathematics, and chemistry is required. Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. Applicants must provide complete transcripts and two letters of recommendation. A personal interview is desirable.

### Doctoral Degree Requirements

The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of one foreign language.

### Other Relevant Information

This program is offered only at The Milton S. Hershey Medical Center.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## ANATOMY (ANAT)

501. FUNDAMENTALS OF GROSS ANATOMY I (3) Macroscopic structure of the upper extremity, head, and neck, with emphasis on normal organization, functional correlations, and clinical significance.



502. **FUNDAMENTALS OF GROSS ANATOMY II (3)** Macroscopic structure of the thorax, abdomen, pelvis, and lower extremity, with emphasis on normal organization, functional correlations, and clinical significance. Prerequisite: Anat. 501.
505. **MICROSCOPIC ANATOMY (4)** Microscopic organization of tissues and cells; interrelationships of cells; chemical and functional specialization of cells.
510. **NEUROBIOLOGY (3)** Morphology and function of the sense organs, general organization of the brain, and physiological studies of central nervous system function.
512. **HUMAN EMBRYOLOGY (2)** A basic study of the development of the human embryo, including gamete production and fusion, implantation, and organogenesis.
513. **COMPARATIVE MORPHOGENESIS (3)** A descriptive and experimental study of vertebrate and invertebrate development.
515. **DEVELOPMENTAL NEUROBIOLOGY (2)** Development of the nervous system in all aspects.
530. **DISSECTION (2-4)** Intensive laboratory study of selected regions of the human body. Coverage and credit arranged by consultation.
535. **SUBMICROSCOPIC ANATOMY (3)** Current literature on molecular and micellar organization of cells and tissues in diverse systems; application of interference and electron microscopy. Prerequisite: Anat. 505.
542. **COMPARATIVE NEUROLOGY (3)** Topics in functional anatomy and neurophysiology. The comparative approach to the organization of the mammalian nervous system will be stressed. Prerequisite: Anat. 510.
543. **SENSORY PROCESSES (3)** Morphological, physiological, and psychophysical aspects of mammalian sensory systems; emphasizing somatic, sensory, visual, and auditory systems. May be repeated. Prerequisite: Anat. 510.
545. **COMPARATIVE AUDITORY AND VISUAL ANATOMY (3-5)** An introduction to the morphology and evolution of the vertebrate eye and ear; individualized laboratory work arranged by consultation.
550. **SEMINAR IN QUANTITATIVE OPTICS (3)** Study of the various types of light microscopy instruments and application of these tools to quantitative measurements in biological systems. Prerequisite: Anat. 505.
590. **COLLOQUIUM (1-3)**
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**

## ANIMAL NUTRITION (A NTR)

ROLAND M. LEACH, *Chairman of the Committee on Animal Nutrition*  
 205 Animal Industries Building  
 814-865-5082

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Craig R. Baumrucker, Ph.D. (Purdue) *Associate Professor of Animal Nutrition-Physiology*  
 Robert L. Cowan, Ph.D. (Penn State) *Professor of Animal Nutrition*  
 Terry D. Etherton, Ph.D. (Minnesota) *Assistant Professor of Animal Nutrition*  
 Truman V. Hershberger, Ph.D. (Ohio State) *Associate Professor of Animal Nutrition*  
 Earl M. Kesler, Ph.D. (Penn State) *Professor of Dairy Science*  
 Roland M. Leach, Jr., Ph.D. (Cornell) *Professor of Poultry Science*  
 Robert D. McCarthy, Ph.D. (Maryland) *Professor of Food Science*  
 Jose Mendez, Ph.D. (Minnesota) *Professor of Health and Applied Physiology*  
 Lawrence D. Muller, Ph.D. (Purdue) *Professor of Dairy Science*  
 Richard W. Scholz, Ph.D. (Purdue) *Professor of Veterinary Science*  
 Paul J. Wangsness, Ph.D. (Iowa State) *Professor of Animal Nutrition*

## ANIMAL NUTRITION

### Associate Members of the Graduate Faculty

Harold W. Harpster, Ph.D. (Michigan State) Assistant Professor of Animal Nutrition  
Ronald S. Kensinger, Ph.D. (Florida) Assistant Professor of Animal Nutrition-Physiology  
William B. Roush, Ph.D. (Oregon State) Assistant Professor of Poultry Science  
Paul R. Shellenberger, Ph.D. (Iowa State) Professor of Dairy Science  
Thomas F. Sweeney, Ph.D. (Kentucky) Assistant Professor of Dairy Science

This is an interdepartmental graduate program designed to enable students to obtain thorough training in animal nutrition. The program is under the direction of a committee composed of graduate faculty members of the Departments of Animal and Dairy Science, Poultry Science, and Veterinary Science, and the Human Performance Research Laboratory. Programs are offered in ruminant and nonruminant nutrition, including physiology of nutrition; nutritional requirements for productive functions; metabolism of carbohydrates, lipids, proteins, vitamins, and minerals; and regulation of food intake and other metabolic functions.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Undergraduate preparation should include organic and analytical chemistry, physics, biology, and mathematics. Students may be admitted with limited deficiency but are required to make up undergraduate deficiencies without graduate credit. Students should have an appropriate background and a 3.00 average in the major area and in related sciences. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum requirements may be made for students with special backgrounds, abilities, and interests.

### Degree Requirements

The communication and foreign language requirement for the Ph.D. degree may be satisfied by options selected from designated areas including, but not restricted to, foreign languages.

### Other Relevant Information

The following nutrition courses are offered by participating departments, and their descriptions may be found under the listings of the appropriate departments: D.Sc. 511, Pty.Sc. 502, and V.Sc. 535. Courses related to animal nutrition can be found under the following listings in the Graduate Bulletin: Animal Science, Biochemistry, Food Science, Physiology, Poultry Science, and Veterinary Science. For other graduate courses in this subject area see courses listed under Nutrition, such as Nutr. 552, 556, and 557.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## ANIMAL NUTRITION (A NTR)

- 401. PHYSIOLOGY OF NUTRITION (3) McCarthy
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

501. ENERGY METABOLISM (3) Integration of biochemical, nutritional, and physiological processes in energy metabolism; concepts underlying the application of bioenergetics and calorimetry to metabolism. Prerequisites: 3 credits each in nutrition and physiology; Bioch. 402.

503. MICRONUTRIENTS: NUTRITION, METABOLISM, AND FUNCTION (2) Functional approach to the study of vitamins and trace elements in the nutrition and metabolism of animals and man. Prerequisites: 3 credits each in biochemistry, nutrition, and physiology.

505. RUMINOLOGY (3) Physiological, biochemical, and microbiological activities occurring within the rumen and the relation of rumen function to animal response. Prerequisites: at least one course in each of the following areas: animal nutrition, physiology, microbiology, and biochemistry.



590. COLLOQUIUM (1-3)  
 596. INDIVIDUAL STUDIES (1-9)  
 597. SPECIAL TOPICS (1-9)

## ANIMAL SCIENCE (AN SC)

PAUL J. WANGSNESS, *Head of the Department of Dairy and Animal Science*  
 324 Animal Industries Building  
 814-863-3665

**Degrees Conferred:** Ph.D., M.S., M.Agr.

### Senior Members of the Graduate Faculty

John O. Almquist, Ph.D. (Penn State) *Professor of Dairy Physiology*  
 Clifton A. Baile, Ph.D. (Missouri) *Adjunct Professor of Animal Nutrition*  
 Craig R. Baumrucker, Ph.D. (Purdue) *Associate Professor of Animal Nutrition – Physiology*  
 Robert L. Cowan, Ph.D. (Penn State) *Professor of Animal Nutrition*  
 Terry D. Etherton, Ph.D. (Minnesota) *Assistant Professor of Animal Nutrition*  
 Robert J. Flipse, Ph.D. (Michigan State) *Professor of Dairy Science*  
 George L. Hargrove, Ph.D. (North Carolina State) *Associate Professor of Dairy Science*  
 Truman V. Hershberger, Ph.D. (Ohio State) *Associate Professor of Animal Nutrition*  
 Earl M. Kesler, Ph.D. (Penn State) *Professor of Dairy Science*  
 Robert D. McCarthy, Ph.D. (Maryland) *Professor of Food Science*  
 Lawrence D. Muller, Ph.D. (Purdue) *Professor of Dairy Science*  
 Phillip L. Senger, Ph.D. (Virginia Tech.) *Associate Professor of Dairy Physiology*  
 Grant W. Sherritt, Ph.D. (Penn State) *Associate Professor of Animal Science*  
 Tsuneo Y. Tanabe, Ph.D. (Wisconsin) *Associate Professor of Dairy Physiology*  
 Paul J. Wangsness, Ph.D. (Iowa State) *Professor of Animal Nutrition*  
 Lowell L. Wilson, Ph.D. (South Dakota State) *Professor of Animal Science*  
 John H. Ziegler, Jr., Ph.D. (Penn State) *Professor of Meat Science*

### Associate Members of the Graduate Faculty

Stephen M. Abrams, Ph.D. (Florida) *Adjunct Assistant Professor of Dairy Science*  
 Richard S. Adams, Ph.D. (Minnesota) *Professor of Dairy Science Extension*  
 Lester A. Burdette, Ph.D. (Penn State) *Professor of Animal Science Extension*  
 Erskine H. Cash, Ph.D. (Michigan State) *Associate Professor of Animal Science*  
 Daniel R. Hagen, Ph.D. (Illinois) *Assistant Professor of Animal Science*  
 Harold W. Harpster, Ph.D. (Michigan State) *Assistant Professor of Animal Nutrition*  
 Ronald S. Kensinger, Ph.D. (Florida) *Assistant Professor of Animal Nutrition – Physiology*  
 Thomas B. King, Ph.D. (Illinois) *Professor of Animal Science*  
 Thomas L. Merritt, Ph.D. (Ohio State) *Professor of Animal Science*  
 Michael L. O'Connor, Ph.D. (Virginia Tech.) *Assistant Professor of Dairy Science Extension*  
 Paul R. Shellenberger, Ph.D. (Iowa State) *Professor of Dairy Science*  
 Lawrence W. Specht, Ph.D. (Michigan State) *Professor of Dairy Science Extension*  
 Thomas F. Sweeney, Ph.D. (Kentucky) *Assistant Professor of Dairy Science*  
 Howard W. Thoele, Ph.D. (Minnesota) *Associate Professor of Dairy Science*

Students may specialize in animal management systems; breeding and genetics; meat science; metabolism, including growth and body composition; nutrition of various farm animal species; and reproductive, lactational, and general animal physiology. Ruminant, nonruminant, small-animal, and wildlife species are available.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Prerequisite to graduate work is the completion of an undergraduate major in animal industry, animal science, dairy science, or a related area. The undergraduate program must include biological sci-

## ANIMAL SCIENCE

ences, chemistry, mathematics, and (except for M.Agr.) general physics. Students may be admitted with limited deficiency but are required to make up undergraduate deficiency work without degree credit.

Students with a 2.80 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.80 grade-point average may be made for students with special backgrounds, abilities, and interests.

### Degree Requirements

The M.Agr. is a professional program designed to prepare individuals for specialist and management positions in county agricultural extension, government, or industry and does not require a thesis. The academic M.S. and Ph.D. programs require a thesis and are designed for those primarily interested in education and research. The requirements of these programs are detailed in the departmental publication "Requirements of the Graduate Program in Animal Science." The communication and foreign language requirement for the Ph.D. degree may be satisfied by competence in either one foreign language or communication skills.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

**MICASU SCHOLARSHIP** — Available to a graduate student in animal industry who has financial need and who has demonstrated academic achievement and improvement during the graduate program; stipend \$600.

**PENNSYLVANIA MEAT PACKERS' ASSOCIATION SCHOLARSHIP** — Open to a selected graduate student specializing in meat science; stipend \$600. Apply through the Department of Dairy and Animal Science.

## ANIMAL SCIENCE (AN SC)

- 406. SWINE MANAGEMENT AND PRODUCTION (3)
- 407. ADVANCED HORSE PRODUCTION AND MANAGEMENT (2)
- 408. SHEEP PRODUCTION AND MANAGEMENT (3)
- 409. BEEF PRODUCTION AND MANAGEMENT (3)
- 410. DAIRY HERD MANAGEMENT (4)
- 420. ANIMAL NUTRITION AND FEEDING TECHNOLOGY (2)
- 421. APPLIED FEEDING OF BEEF CATTLE AND SHEEP (1)
- 422. APPLIED FEEDING OF DAIRY CATTLE (2)
- 423. APPLIED FEEDING OF SWINE, POULTRY, AND LABORATORY ANIMALS (1)
- 427. MILK SECRETION (3)
- 431. PHYSIOLOGY OF REPRODUCTION IN FARM ANIMALS (3)
- 442. QUANTITATIVE INHERITANCE AND ANIMAL BREEDING (3)
- 455. ANIMAL GENETICS (2)
- 464. (Biol. 464) ANIMAL BEHAVIOR—SOCIOBIOLOGY (3)
- 490. ANIMAL PRODUCTION COLLOQUIUM (1)
- 491. DAIRY PRODUCTION COLLOQUIUM (1)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 505. ANIMAL BREEDING (1-6) Special problems in animal genetics as applied to breeding and improvement of horses, cattle, sheep, and swine. Prerequisites: An.Sc. 322; 3 credits in statistics.
- 510. ANIMAL SCIENCE RESEARCH METHODS (3) Application of scientific method; experimental design and procedures; analyzing, interpreting, and reporting research results. Prerequisite: 3 credits of 400-level statistics.
- 511. ANIMAL NUTRITION AND MANAGEMENT (1-6) Developments in the nutrition and management of farm livestock. Prerequisites: An.Sc. 406 or 407 or 408 or 409 or 410; A.Ntr. 401.
- 512. STUDIES IN MILK SECRETION (1-6) Physiology of milk secretion. Prerequisite: An.Sc. 427.



514. **ANIMAL GROWTH AND DEVELOPMENT (3)** Cellular, metabolic, and nutritional aspects of fetal and postnatal tissue growth; role of the endocrine system in regulation of animal growth. Prerequisites: 3 credits in biochemistry; 3 credits in physiology.

515. **ADVANCED PHYSIOLOGY OF REPRODUCTION IN FARM ANIMALS (1-6)** Advanced physiology of reproduction in farm animals. Prerequisites: 3 credits each in reproductive physiology, systemic physiology, and endocrinology.

590. **COLLOQUIUM (1-3)**

596. **INDIVIDUAL STUDIES (1-9)**

597. **SPECIAL TOPICS (1-9)**

602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)**

NOTE: See *Animal Nutrition, Physiology, and Food Science*.

## ANTHROPOLOGY (ANTHY)

PAUL T. BAKER, *Head of the Department*  
409 Carpenter Building  
814-865-2509

**Degrees Conferred:** Ph.D., M.A.

### Senior Members of the Graduate Faculty

Paul T. Baker, Ph.D. (Harvard) *Evan Pugh Professor of Anthropology*  
Robert B. Eckhardt, Ph.D. (Michigan) *Associate Professor of Anthropology*  
Gabriel Escobar, Ph.D. (Cornell) *Associate Professor of Anthropology*  
Edward E. Hunt, Jr., Ph.D. (Harvard) *Professor of Anthropology and Health Education*  
Frederick R. Matson, Ph.D. (Michigan) *Professor Emeritus of Anthropology*  
Joseph W. Michels, Ph.D. (UCLA) *Professor of Anthropology*  
Warren T. Morrill, Ph.D. (Chicago) *Professor of Anthropology*  
William T. Sanders, Ph.D. (Harvard) *Professor of Anthropology*  
David L. Webster, Ph.D. (Minnesota) *Associate Professor of Anthropology*

### Associate Members of the Graduate Faculty

Thelma S. Baker, D.Ed. (Penn State) *Assistant Professor of Anthropology and Social Science*  
Stephen J. Beckerman, Ph.D. (New Mexico) *Assistant Professor of Anthropology*  
James W. Hatch, Ph.D. (Penn State) *Assistant Professor of Anthropology*  
Jeffrey A. Kurland, Ph.D. (Harvard) *Assistant Professor of Anthropology*  
Ellen M. Woolford, Ph.D. (Duke) *Assistant Professor of Anthropology and Linguistics*

The master's program is designed to train students in general anthropology. The doctoral program is structured to train students in the following areas of specialization: ethnology (with subspecialization in social anthropology, demographic anthropology, cognitive anthropology, or cultural evolution and ecology); archaeology (with subspecialization in cultural ecology, analytical approaches, technological methods, or culture areas); biological anthropology (with subspecialization in human adaptability, genetics, biological demography, human evolution, or the behavioral biology of human and non-human primates).

### Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.

Undergraduate preparation must include 12 credits in anthropology and archaeology or their equivalent. A student with an excellent record but who does not meet these requirements may be admitted provided course deficiencies are made up without graduate credit. Students with a 3.00 or higher junior-senior average and with appropriate course backgrounds who have research interests directly

related to the special anthropological competences within the department will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

## Master's Degree Requirements

M.A. candidates may submit either a thesis or a term paper. If the latter is chosen, 6 credits in 500-level courses in the major field must be scheduled in lieu of thesis credits. The M.A. degree may be bypassed by exceptional candidates for the Ph.D. degree.

## Doctoral Degree Requirements

The communication and foreign language requirement for the Ph.D. degree includes a reading knowledge of a foreign language plus an option from among additional foreign languages, field languages, linguistics, or statistics.

## Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

HILL FELLOWSHIPS FOR STUDY IN ANTHROPOLOGY OR HISTORY — Details available from Dean S. F. Paulson of the College of the Liberal Arts, 108 Sparks Building.

## ANTHROPOLOGY (ANTHY)

401. HUMAN EVOLUTION: THE MATERIAL EVIDENCE (3)
  402. HUMAN ADAPTATION (3)
  405. PRIMATOLOGY (3)
  408. DEMOGRAPHIC METHODS IN ANTHROPOLOGY (3)
  409. QUANTITATIVE ANALYSIS OF ANTHROPOLOGICAL DATA (2)
  410. OSTEOLOGY LABORATORY (1)
  411. DESCRIPTIVE METHODS LABORATORY (1)
  412. ANTHROPOLOGICAL GENETICS LABORATORY (1)
  414. SYSTEMATIC INSTRUCTION IN ANTHROPOLOGY (3)
  415. (Ed.Th.P. 415) ANTHROPOLOGY OF EDUCATION (3)
  420. ARCHAEOLOGY OF THE NEAR EAST (3)
  422. MESO-AMERICAN ARCHAEOLOGY AND ETHNOGRAPHY (4)
  423. THE EVOLUTION OF AMERICAN INDIAN CULTURE (4)
  440. SOUTH AMERICAN TRIBAL SOCIETIES (3)
  441. ETHNOLOGY OF THE ANDEAN REGION (3)
  450. COMPARATIVE SOCIAL ORGANIZATION (3)
  451. ECONOMIC ANTHROPOLOGY (3)
  453. (Soc. 453) PRIMITIVE RELIGION (3)
  454. POLITICAL ANTHROPOLOGY (3)
  456. CULTURAL ECOLOGY (3)
  457. LANGUAGE IN CULTURE (3)
  458. PRIMATE SOCIOBIOLOGY (3)
  461. METHODS IN CULTURAL ANTHROPOLOGY (3)
  488. ARCHAEOLOGICAL METHODS AND THEORY (3)
  496. INDEPENDENT STUDIES (1-18)
  497. SPECIAL TOPICS (1-9)
- 
501. HUMAN EVOLUTION: THE MATERIAL EVIDENCE (4) Human origins as seen in the fossil record and comparative biology of humans and their primate relatives.
  502. HUMAN ADAPTATION THEORY (4) Theory, mechanism, and examples of how human populations biologically adapted to varying environments. Prerequisite: 3 credits in physical anthropology.
  508. RESEARCH PROBLEMS IN CULTURE HISTORY (3-9)
  511. (HI.Ed. 511) HEALTH IMPLICATIONS IN THE GROWTH AND DEVELOPMENT OF SCHOOL CHILDREN (3) Child growth and development emphasis for teachers; medical inspection and examination; preschool program; early habit formations; behavior problems.



513. (Hl.Ed. 513) **HEALTH IMPLICATIONS IN MATURITY AND AGING** (3) Changes in the human body in maturity and aging; mechanisms of physiologic aging; implications for health and preventive medicine. Prerequisite: Anthy. (Hl.Ed.) 511.

522-523. **ECOLOGICAL THEORY IN ANTHROPOLOGY** (3 each) Man's biology, culture history, and culture variation from the ecological perspective. Two-semester enrollment required. Prerequisites: 6 credits in anthropology.

530. **INDIVIDUAL READINGS IN ANTHROPOLOGY** (1-6) Reading or research in selected aspects of general anthropology.

531. **INDIVIDUAL RESEARCH IN ANTHROPOLOGY** (3-12)

545. **SEMINAR IN ANTHROPOLOGY** (1-9) Critical analysis of research in selected areas of anthropology.

558. **ETHNOLOGY PROSEMINAR I** (4) Ethnological paradigms used in the description, analysis, and explanation of culture: ecology, social organization, and language.

559. **ETHNOLOGY PROSEMINAR II** (4) Ethnological paradigms used in the description, analysis, and explanation of culture: cognition, development, and adaptation.

561. **FIELD METHODS IN ANTHROPOLOGY** (3-9) Individual field work in any aspect of anthropology, supervised by staff of professional rank.

562. **LABORATORY METHODS IN ANTHROPOLOGY** (3-9) Supervised laboratory research, utilizing materials from physical anthropology or archaeology or cultural anthropology.

563. **SEMINAR IN LINGUISTIC ANTHROPOLOGY** (3-6) Organized research on special topics in linguistic anthropology.

588. **METHOD AND THEORY IN ARCHAEOLOGY** (4) Methodological strategies and tactics in archaeological research; major theories in cultural anthropology as applied to archaeological data.

597. **SPECIAL TOPICS** (1-9)

## ARCHITECTURAL ENGINEERING (A E)

GIFFORD H. ALBRIGHT, *Head of the Department*

104 Engineering A Building

814-865-6394

**Degree Conferred:** M.S.

### Senior Members of the Graduate Faculty

Luis H. Summers, Ph.D. (Notre Dame) *Professor of Architectural Engineering*

Jiri Tichy, D.Sc. (Prague Inst. of Tech.) *Professor of Architectural Engineering*

### Associate Members of the Graduate Faculty

Gifford H. Albright, S.M. (M.I.T.) *Professor of Architectural Engineering*

Louis F. Geschwindner, Ph.D. (Penn State) *Assistant Professor of Architectural Engineering*

Stanley F. Gilman, Ph.D. (Illinois) *Professor of Architectural Engineering*

Students may specialize in structural analysis and design, environmental control engineering (including energy conservation and energy management in building), solar energy applications, illumination, acoustics, materials of construction, building construction management, and computer application to building design and performance.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

For admission a student must have a strong background in some field of engineering; in engineering science or mechanics; or in architecture, psychology, economics, or management if there is adequate preparation in the physical sciences and mathematics. The detailed requirements depend upon the student's area of special interest.

Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## ARCHITECTURAL ENGINEERING (A E)

- 401. STRUCTURAL DESIGN OF BUILDINGS (3)
- 402. STRUCTURAL DESIGN OF BUILDINGS (3)
- 403. STRUCTURAL DESIGN OF BUILDINGS (3)
- 430. INDETERMINATE STRUCTURES (3)
- 431. STRUCTURAL DESIGN OF BUILDINGS (3)
- 439. MODERN STRUCTURAL SYSTEMS (3)
- 441. INTEGRATION OF ARCHITECTURAL ENGINEERING SYSTEMS (3)
- 454. ADVANCED HEATING, VENTILATING, AND AIR CONDITIONING (3)
- 455. ADVANCED HEATING, VENTILATING, AND AIR CONDITIONING SYSTEM DESIGN (3)
- 456. SOLAR ENERGY BUILDING SYSTEM DESIGN (3)
- 458. ADVANCED ARCHITECTURAL ACOUSTICS AND NOISE CONTROL (3)
- 461. BASIC THEORY OF BUILDING ILLUMINATION (3)
- 464. ADVANCED ARCHITECTURAL ILLUMINATION SYSTEMS DESIGN (3)
- 471. BUILDING CONSTRUCTION ASSEMBLIES (3)
- 472. BUILDING CONSTRUCTION MANAGEMENT (3)
- 473. BUILDING CONSTRUCTION MANAGEMENT (3)
- 474. BUILDING CONSTRUCTION ESTIMATING (3)
- 475. BUILDING CONSTRUCTION ENGINEERING I (3)
- 476. BUILDING CONSTRUCTION ENGINEERING II (3)
- 477. SENIOR BUILDING CONSTRUCTION PROJECT (3)
- 481. COMPREHENSIVE ARCHITECTURAL ENGINEERING SENIOR PROJECT (4)
- 482. COMPREHENSIVE ARCHITECTURAL ENGINEERING SENIOR PROJECT (4)
- 486. PROFESSIONAL ENGINEERING PRACTICE (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

542. ADVANCED PROBLEMS AND RESEARCH IN ARCHITECTURAL ENGINEERING (2-12) Investigation, analysis, and preparation of comprehensive report on subject relating to special problems in architectural engineering systems.

545. ARCHITECTURAL ENGINEERING SEMINAR (1-6) Current literature and special problems in architectural engineering; presentation of technical papers.

## ARCHITECTURE (ARCH)

RANIERO CORBELLETTI, *Head of the Department*  
206 Engineering Unit C  
814-865-9535

**Degrees Conferred:** M.S., M.Arch.

### Senior Members of the Graduate Faculty

Raniero Corbelletti, M.S.Arch. (Columbia) *Professor of Architecture*  
Gideon Golany, Ph.D. (Hebrew, Jerusalem) *Professor of Urban and Regional Planning*  
Wladyslaw A. Strumillo, Dr.Arch. (Polytechnic Institute, Warsaw) *Associate Professor of Architecture*



**Associate Members of the Graduate Faculty**

Arthur Anderson, Jr., M.F.A. (Princeton) *Associate Professor of Architecture*

Pier Luigi Bandini, Dr.Arch. (University of Florence, Italy) *Assistant Professor of Architecture*

Louis Inserra, M.Arch. (Yale) *Associate Professor of Architecture*

Roy S. Vollmer, M.Arch. (Pennsylvania) *Associate Professor of Architecture*

The Master of Science is an academic degree available to students with training in other design-related fields, as well as to students with a professional degree in architecture reentering the University for study in a specialty. Advanced studies are offered in architecture, urban design, and planning. The student is offered an opportunity for independent research and extensive interdisciplinary work under the guidance of specialists and scholars in technical, cultural, industrial, and social fields.

The Master of Architecture degree program is planned to provide the depth and breadth of knowledge needed to enter the architectural profession and become licensed as a professional architect after the required period of internship.

**Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. Admission to the Master of Architecture program requires the equivalent of 39 credits in design-research work and a B.A. or B.S. degree with a major in architecture or environmental design or holding other nonprofessional degrees in architecture.

All applicants must submit (1) a minimum of two statements of recommendation from faculty members acquainted with the applicant's academic history and/or recommendations by an undergraduate review committee; (2) a paper of no more than 500 words stating the applicant's concept of graduate education in architecture and describing his or her personal commitment and professional interests and goals; and (3) a portfolio of design work (architecture and planning projects) executed at the undergraduate level or under professional guidance, or independently, provided that such work can be evidenced as executed by the applicant. A minimum portfolio representation of one project for each year of academic undergraduate study, or its equivalent, is required.

The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

**Degree Requirements**

A total of 30 credits and a thesis, final project, or research paper are required for the Master of Science degree. This work includes 8 credits in required studio core courses at the 500 level (8 credits), a concentration area (12 credits), electives (4 credits), and the thesis, final project, or research paper (6 credits).

For the Master of Architecture degree, 27 credits in professional core courses, 18 credits in professional area studies based on previous undergraduate experience and course work, and 15 credits of free electives are required. At least 36 credits must be taken at the 500-600 level, and 24 credits in the 400-500 course series are required. A nonthesis option is available for the M.Arch. degree.

**Student Aids**

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

**ARCHITECTURE (ARCH)**

- 411. PLANNING AND DESIGN WITH CLIMATE (3)
- 430. DESIGN-RESEARCH II (6-12)
- 441. ARCHITECTURAL DESIGN ANALYSIS (4)
- 442. ARCHITECTURAL DESIGN ANALYSIS (4)
- 443. ARCHITECTURAL DESIGN ANALYSIS INSPECTION TRIP (1)
- 451. ARCHITECTURAL PROFESSIONAL PRACTICE (3)

- 461. ARCHITECTURAL STRUCTURAL SYSTEMS I (3)
- 462. ARCHITECTURAL STRUCTURAL SYSTEMS II (3)
- 463. ARCHITECTURAL STRUCTURAL SYSTEMS III (3)
- 471. ENVIRONMENTAL CONTROL SYSTEMS I (3)
- 472. ENVIRONMENTAL CONTROL SYSTEMS II (3)
- 481. ADVANCED ARCHITECTURAL DATA SYSTEMS I (3)
- 482. ADVANCED ARCHITECTURAL DATA SYSTEMS II (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

510. URBAN DESIGN POLICY AND IMPLEMENTATION (3) Analysis of urban design: origins, function, accomplishments; examination of urban design policy and of problems encountered in various cities.

515. NEW TOWNS PLANNING SEMINAR (3) Examination of the process, concepts, and structure of new towns planning as a response to contemporary urban-regional development problems.

516. NEW COMMUNITIES SEMINAR (3) Examination and evaluation of the new communities movement in the United States.

517. NEW TOWNS PLANNING PROCESS (3) A systematic study and analysis of the sequence of actions in the new towns planning process.

518. NEW TOWNS RESEARCH SEMINAR (3) Advanced research seminar using comparative case studies of comprehensive contemporary issues of new towns planning. Prerequisites: Arch. 515, 517.

530. ARCHITECTURE I (6-12) Problems in architectural planning and design. Programming and/or implementation methodologies and applications for various environmental design scales.

531. ARCHITECTURE II (6-12) Continuation of Arch. 530 with concentration and specialization options. Prerequisite: Arch. 530.

532. COMPREHENSIVE PLANNING PROCESS STUDIO (6-12) Field case studies in analysis forecasting and projections of urban physical design elements. Preparation of comprehensive plan, regulations, and implementation.

535. NEW TOWNS PLANNING STUDIO (6-12) A team workshop of planning and design of new towns, involving data gathering, surveys, analysis, projection, and implementation.

591. ARCHITECTURAL RESEARCH (2-12) Guided research project.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

## ART (ART)

JERROLD MADDOX, *Director, School of Visual Arts*  
102 Visual Arts Building  
814-865-0444

**Degrees Conferred:** M.A., M.F.A.

### Senior Members of the Graduate Faculty

Edward A. Adams, M.F.A. (Cranbrook Academy of Art) *Associate Professor of Art*  
John A. Cook, M.F.A. (Iowa) *Professor of Art*  
David R. DonTigny, M.A. (Montana) *Professor of Art*  
Stuart H. Frost, B.A. (Penn State) *Professor of Art*  
Bruce R. Shobaken, M.F.A. (Minnesota) *Professor of Art*  
George S. Zoretich, M.A. (Penn State) *Professor of Art*

### Associate Members of the Graduate Faculty

William P. Hanson, Art Dipl. (Fine Arts, Boston) *Associate Professor of Art*  
Marc Hessel, M.F.A. (Iowa) *Associate Professor of Art*  
Gerald Lang, M.F.A. (Minnesota) *Associate Professor of Art*  
Jerrold Maddox, M.F.A. (Indiana) *Professor of Art*  
Richard Mayhew *Associate Professor of Art*



William J. McHale, D.Ed. (Penn State) Associate Professor of Art  
 Stephen Porter, M.F.A. (Cornell) Associate Professor of Art  
 Lanny B. Sommese, M.F.A. (Illinois) Professor of Art  
 James E. Stephenson, Jr., M.A. (Montana) Professor of Art

The M.A. program is planned to provide a broad range of experience and study in the visual arts. The M.F.A. program is planned to provide professional emphasis in a specific area of art.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Requirements for admission to the M.A. program include a broad undergraduate training in art and the presentation of a portfolio of the applicant's work.

Requirements for admission to the M.F.A. program include 36 credits in studio art with some indication of concentration in a chosen area and a statement of purpose concerning the professional aims of the candidate. A portfolio must be presented. A portfolio of slides (quality photographs for sculpture applicants), rather than actual work, is requested. A selection of no fewer than twenty examples should be presented. The majority of these should be in the area of the applicant's interest, but the portfolio should also include a lesser emphasis in related areas.

All students accepted for graduate study in art who lack the adequate undergraduate courses or show deficiencies in some area will be required to take additional course work without degree credit.

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

### Degree Requirements

A thesis in an area of specialization is required for the M.A. degree.

A creative project and supporting monograph are required for the M.F.A. degree.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## ART (ART)

- 411. SEMINAR IN CONTEMPORARY ART (3 per semester, maximum of 6 )
- 415. ADVANCED FIBER ARTS (4 per semester, maximum of 12)
- 417. ADVANCED METAL ARTS (4 per semester, maximum of 12)
- 421. DRAWING (4 per semester, maximum of 12)
- 430. ADVANCED SCULPTURE (4 per semester, maximum of 12)
- 448. ADVANCED PRINTMAKING (4 per semester, maximum of 12)
- 450. ADVANCED PAINTING (4 per semester, maximum of 12)
- 455. ADVANCED PAINTING CRITIQUE (4 per semester, maximum of 8)
- 460. ADVANCED WATER-BASED MEDIA (4 per semester, maximum of 8)
- 470. TIME AND SEQUENCE (4)
- 471-472. SENIOR PROBLEMS (4 each)
- 473. GRAPHIC DESIGN SEMINAR (3)
- 480. ADVANCED CERAMIC ARTS (4 per semester, maximum of 12)
- 491. PHOTOGRAPHY AND OTHER DISCIPLINES (4 per semester, maximum of 12)
- 492. CREATIVE PROJECTS IN PHOTOGRAPHY (4 per semester, maximum of 12)
- 494. GROUP PROJECTS IN PHOTOGRAPHY (4 per semester, maximum of 8)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

## ART EDUCATION

501. **ART RESEARCH (2-6)** Original study and practice in art relating to material, concept, or technique.
530. **ADVANCED SCULPTURE (3-12)** Individual projects in sculpture leading to the development of a collection or body of work representative of the artist.
545. **PRINTMAKING (2-12)** Problems in printmaking leading to the development of a collection or body of work representative of the individual artist.
550. **PAINTING (2-12)** Individual problems in painting leading to the development of a collection or body of work representative of the artist.
570. **DESIGN (2-12)** Individual projects in design, with special emphasis on professional practice in specialized fields of graphic design.
580. **CERAMICS (2-12)** Experimental problems in ceramics leading to the development of a collection or body of work representative of the individual.
595. **PHOTOGRAPHY (2-12)** Individual projects in photography leading to the development of a body of specialized work representative of the artist. Prerequisites: 12 credits in Art 492.

## ART EDUCATION (A ED)

KENNETH R. BEITTEL, *In Charge of Graduate Programs in Art Education*  
268 Chambers Building  
814-865-5601

**Degrees Conferred:** Ph.D., D.Ed., M.S., M.Ed.

### Senior Members of the Graduate Faculty

Kenneth R. Beittel, D.Ed. (Penn State) *Professor of Art Education*  
William R. Bradley, Ph.D. (Minnesota) *Associate Professor of Art Education*  
Harlan E. Hoffa, D.Ed. (Penn State) *Professor of Art Education*  
Robert W. Ott, D.Ed. (Penn State) *Associate Professor of Art Education*  
Alice M. Schwartz, D.Ed. (Penn State) *Professor of Art Education*  
David B. Van Dommelen, M.A. (Michigan State) *Professor of Art Education*  
Brent G. Wilson, Ph.D. (Ohio State) *Professor of Art Education*

### Associate Members of the Graduate Faculty

Albert A. Anderson, Ph.D. (Ohio State) *Associate Professor of Art Education*  
Yar G. Chomicky, M.S. (Penn State) *Professor of Art Education*

This program prepares students for careers in public school art teaching, art supervision, college teaching, administration, or research.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Students who seek admission to the graduate program must make formal application to the admissions committee of the art education program. To be admitted without deficiencies, the student is expected to have completed either a baccalaureate program in art education or a program leading to certification. Such a program would include work in studio art, art history, art education, education, educational psychology, and psychology. Deficiencies may be made up by course work which is not counted as credit toward an advanced degree.

Students with a 2.75 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.75 grade-point average may be made for students with special backgrounds, abilities, and interests. Transcripts should indicate high attainment in appropriate academic and creative work, and recommendations should attest to scholarship



and ability to work independently. Creative work, as shown by slides and photographs, should show a high level of involvement and sensitivity to aesthetic-forming processes.

### Doctoral Degree Requirements

All students are expected to complete two years of teaching before receiving the doctoral degree. A foreign language is not required of all Ph.D. degree candidates. In lieu of a foreign language, students will include a series of research and communications studies pertinent to their interests and to their graduate programs and may include a foreign language approved by the doctoral committee.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## ART EDUCATION (A ED)

- 414. ADVANCED CRAFTS FOR TEACHERS (3-6)
- 420. CERAMICS FOR TEACHERS (3)
- 434. ART APPRECIATION IN THE EDUCATIONAL PROGRAM (3)
- 435. ART IN THE ELEMENTARY SCHOOL (3)
- 436. ART IN THE SECONDARY SCHOOL (3)
- 486. CURRENT PROBLEMS IN ART EDUCATION (2-3)
- 488. ADVANCED MURAL PAINTING IN SCHOOLS (3)
- 489. ART EXPERIENCES WITH CHILDREN (3)
- 490. INTRODUCTION TO RESEARCH IN ART EDUCATION (3)
- 494. SCHOOLS AND MUSEUMS (3)
- 495. INTERNSHIP IN ART EXPERIENCES (12)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 501. SEMINAR IN ART EDUCATION (1-6) The analysis of fundamental concepts derived from related disciplines; the examination of current problems; current literature.
- 504. ADVANCED METHOD IN GRAPHIC PROCESSES (3) Exploration through laboratory experience of printing method: etching, silk screen, linoleum, or other; applications in teaching.
- 514. FUNCTIONAL RELATIONSHIPS IN CRAFTS (3) Relationships of material design and purpose in crafts discussed by means of outstanding products of different materials, periods, and cultures. Prerequisites: 6 credits in crafts, or 3 in design and 3 in advanced crafts.
- 516. ANALYSIS OF THREE-DIMENSIONAL PROCESSES IN ART (3) Three-dimensional processes analyzed with regard to kinetic, textural, form, and other functions.
- 520. ADVANCED CERAMIC ART (3) Intensified exploration of throwing, glazing, and firing processes as related to aesthetic considerations in contemporary art forms and past cultures. Prerequisite: A.Ed. 420.
- 535. ARTS ADMINISTRATION FOR SCHOOLS AND COLLEGES (3) Responsibilities of arts administrators in schools and colleges: program, staff development, supervision, facilities, financing, community relations, governance, and report writing.
- 536. CURRICULUM DEVELOPMENT IN ART EDUCATION (3) Factors affecting art curriculum decisions, analysis, selection, organization, preparation of curriculum. Evaluation and sources of art curriculum improvement and innovation. Prerequisites: 6 credits of methods.
- 541. THEORIES OF CHILD ART (3) Study of current theories of child art; application of recent psychological and anthropological theories to understanding child art. Prerequisite: A.Ed. 486 or 501.
- 545. EVALUATION AND ASSESSMENT IN ART EDUCATION (3) Study of theories of evaluation; application of judgmental criteria; analysis and construction of assessment instruments and scoring procedures. Prerequisites: A.Ed. 490, 501.
- 588. HISTORY OF ART EDUCATION (3) Historical development of philosophies in art education in the United States and abroad.
- 589. RESEARCH METHODS IN ART EDUCATION (3-6) Orientation in research methods; findings and designs related to the study of problems in art education.

## ART HISTORY

### 590. COLLOQUIUM (1-3)

595. RESEARCH IN ART EDUCATION (1-6) Independent research, under an adviser, to be terminated by a scholarly report proportionately comparable in quality to a master's thesis. Prerequisites: 15 credits in art education at the 400 and 500 levels, including A.Ed. 589.

### 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## ART HISTORY (ART H)

HELLMUT W. HAGER, *Head of the Department*  
229 Arts II Building  
814-865-6326

**Degrees Conferred:** Ph.D., M.A.

### Senior Members of the Graduate Faculty

Eugenio Battisti, Ph.D. (Rome) *Evan Pugh Professor of Art History*  
Anthony Cutler, Ph.D. (Emory) *Professor of Art History*  
Roland Fleischer, Ph.D. (Johns Hopkins) *Professor of Art History*  
Hellmut Hager, Ph.D. (Universität, Bonn) *Professor of Art History*  
Heinz Henisch, Ph.D. (Reading) *Professor of the History of Photography*  
George Mauner, Ph.D. (Columbia) *Professor of Art History*  
Jeanne Chenault Porter, Ph.D. (Michigan) *Associate Professor of Art History*

Graduate work is offered in the following areas: Ancient art, Medieval and Byzantine art, Renaissance and Baroque art, and Modern art. Special research opportunities are available through the Center for the Study of Renaissance and Baroque Art, an area of concentration within the art history department.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Candidates with a 3.00 junior-senior grade-point average and a minimum of 21 credits in art history will be considered for admission to the master's program. Lacking these, a promising candidate may be accepted on condition that deficiencies be remedied, but without graduate degree credit. The best-qualified applicants will be accepted up to the number of spaces that are available for new students.

### Master's Degree Requirements

Candidates for the M.A. degree are required to complete a minimum total of 45 credits, including course work in the four major areas of art historical study (Ancient, Byzantine-Medieval, Renaissance-Baroque, Modern) and a master's thesis. In addition, candidates must demonstrate a reading knowledge of two foreign languages, one of which must be German. The other language is normally French or Italian. Reading knowledge of one of these languages must be demonstrated before the end of three semesters of study. These regulations apply equally to Ph.D. students. For those students wishing to enter the doctoral program who have already completed a master's degree from another university, a reading knowledge of one foreign language will be required before the student can be considered for admission to the department.

A combined M.A./Ph.D. candidacy examination must be passed with a grade of at least "B" for M.A. students, and a grade of "A" is required for acceptance to Ph.D. candidacy. Passing the examination may be accomplished any time before receiving the M.A. degree.

### Doctoral Degree Requirements

Twenty-four additional credits in art history courses, not including doctoral dissertation research, are required for the Ph.D. At the discretion of the candidate's departmental committee, the candidate



may be required to take additional specialized courses pertaining to his or her major area of study. For the Ph.D., a written comprehensive examination and a final oral examination must be successfully completed in addition to the student's doctoral dissertation.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

### ART HISTORY (ART H)

401. STUDIES IN GREEK ART (3)
  402. THE ILLUMINATED MANUSCRIPT (3)
  404. THE ART OF COLONIAL AMERICA (3)
  405. PIONEERS OF MODERN ARCHITECTURE (3-6)
  410. TASTE AND CRITICISM IN ART (3)
  411. ROMAN ART (3)
  412. THE GOTHIC CATHEDRAL (3)
  414. ITALIAN BAROQUE PAINTING (3)
  415. THE SKYSCRAPER (3)
  416. AMERICAN PAINTING: 1876-1913 (3)
  421. ETRUSCAN ART (3)
  422. STUDIES IN MEDIEVAL SCULPTURE (3)
  423. STUDIES IN ITALIAN RENAISSANCE ART (3-9)
  424. MASTERS OF NORTHERN BAROQUE ART (3)
  430. GOYA AND HIS TIMES (3)
  432. PROBLEMS IN ICONOLOGY (3)
  435. STUDIES IN MODERN ART (3-6)
  442. EARLY CHRISTIAN ART (3)
  450. THE HISTORY OF PHOTOGRAPHY (3)
  452. BYZANTINE ART (3)
  454. SPANISH BAROQUE ART (3)
  456. GIAN LORENZO BERNINI AND THE ARCHITECTURE OF THE FULL BAROQUE IN ROME (3)
  458. ROMAN ROCOCO ARCHITECTURE AND THE DAWN OF NEOCLASSICISM (3)
  464. FRENCH BAROQUE PAINTING (3)
  496. INDEPENDENT STUDIES (1-18)
  497. SPECIAL TOPICS (1-9)
- 
510. STUDIES IN ART HISTORY (3-6 per semester) Original investigation in art history, to be pursued independently or concurrently with course work in particular fields.
  511. SEMINAR IN ANCIENT ART (3-12) Selected topics from the history of Greek and Roman art.
  512. SEMINAR IN MEDIEVAL ART (3-12) Original research into problems dealing with the art of the Middle Ages.
  513. SEMINAR IN RENAISSANCE ART (3-12) Investigations in the area of Renaissance art, centering around major masters and monuments.
  514. SEMINAR IN BAROQUE ART (3-12) Investigations in the area of baroque art, centering around major masters and monuments.
  515. SEMINAR IN MODERN ART (3-12) Lectures, readings, reports, and discussions in the field of modern art.
  517. SEMINAR IN EIGHTEENTH-CENTURY ART (3-12) Investigation into themes and problems dealing with eighteenth-century art.
  520. SEMINAR IN SPANISH BAROQUE PAINTING (1-6) Specific problems in the history of seventeenth-century Spanish painting.
  522. SEMINAR IN BYZANTINE ART (3-12) Specific iconographical and stylistic problems in Byzantine art and its relation to classical antiquity, the medieval West, and Islam.
  525. SEMINAR IN MODERN ARCHITECTURE (3-12) Investigation into the works and problems of modern architecture as they relate to the culture of our times.

542. **THE ILLUSTRATION OF THE APOCALYPSE (3-6)** Studies in the illustration of the Apocalypse, iconographical and stylistic, from the early Christian period through Dürer.
551. **HISTORIOGRAPHY OF ART HISTORY (1-6)** The relationship between the definition of, and approach to, art-historical problems from Vasari to the present.
552. **PROBLEMS IN CONNOISSEURSHIP (3)** A study of the problems of authenticating, attributing, and dating paintings and sculpture through internal evidence.
555. **ART HISTORY FIELD SEMINAR (3-12)** Investigations based on the site study of specific art objects, with trips in successive years to different art centers.
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**
602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)**

## ASTRONOMY (ASTRO)

SATOSHI MATSUSHIMA, *Head of the Department*  
525 Davey Laboratory  
814-865-0418

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Gordon P. Garmire, Ph.D. (M.I.T.) *Professor of Astronomy*  
Satoshi Matsushima, D.Sc. (Tokyo) *Professor of Astronomy*  
Douglas H. Sampson, Ph.D. (Yale) *Professor of Astrophysics*  
Peter D. Usher, Ph.D. (Harvard) *Associate Professor of Astronomy*  
Daniel W. Weedman, Ph.D. (Wisconsin) *Professor of Astronomy*

### Associate Members of the Graduate Faculty

Willem A. Baan, Ph.D. (M.I.T.) *Assistant Professor of Astronomy*  
Eric D. Feigelson, Ph.D. (Harvard) *Assistant Professor of Astronomy*  
Don. N. Page, Ph.D. (Cal. Tech.) *Assistant Professor of Physics*  
Lawrence W. Ramsey, Ph.D. (Indiana) *Associate Professor of Astronomy*

Graduate instruction and research opportunities are available in both theoretical and observational astronomy and astrophysics. Currently active areas of theoretical research include atomic processes and radiative transfer, plasma astrophysics, theory of stellar atmospheres, interstellar medium, gaseous nebulae, mass loss and other problems related to fluid flow, galactic structure, high-energy astrophysics, and relativity and cosmology. Observational areas include spectroscopic, photometric, and radio frequency observations of quasars and galaxies; high-resolution spectroscopy of early- and late-type stars, peculiar stars, variable stars, white dwarfs, and stellar flare phenomena; satellite observations of ultraviolet and X-ray spectra of stars and galactic sources; X-ray data from HEAO-1 and the Einstein Observatory on galactic and extragalactic X-ray sources and the diffuse X-ray background; sounding rocket and satellite instrumentation of X-ray and EUV telescopes and detectors; and electronic and computer instrumentation.

The center of observational research facilities is the Penn State Black Moshannon Observatory, located twenty-five miles northwest of the University Park Campus. Basic instruments are telescopes of 1.6m and 0.6m aperture and a variety of spectrographs and photometers equipped with modern detectors and data acquisition systems. Supplementing the local facilities, national facilities such as Kitt Peak, Cerro Tololo, Sacramento Peak, and Hale, Arecibo, and National Radio Astronomy observatories, as well as satellite observatories, are used by Penn State faculty and graduate students.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are*



*in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Applicants with a bachelor's degree in astronomy or an allied field such as physics, mathematics, or geophysics are given equal consideration for admission. Opportunity to make up possible undergraduate deficiencies is provided. GRE scores, including the advanced test, and a grade-point average of 3.00 or better for junior-senior courses in astronomy and related subjects are necessary for consideration for admission. Exceptions to these minimum requirements may be made for students with special backgrounds, abilities, and interests.

### Degree Requirements

A nonthesis option is available for the M.S. degree.

Because modern astronomy has very close ties with mathematics, physics, and engineering, the program required of a doctoral candidate normally includes some courses in these related fields, in addition to those in astronomy. Proficiency in French, German, or Russian is required. A knowledge of computer programming may be substituted for the foreign language requirement.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## ASTRONOMY (ASTRO)

- 430. GENERAL ASTRONOMY FOR TEACHERS (3)
- 440. INTRODUCTION TO ASTROPHYSICS (3)
- 450. PRACTICAL ASTRONOMY (3)
- 460. FUNDAMENTALS OF CELESTIAL MECHANICS (3)
- 470. SOLAR PHYSICS (3)
- 480. NEBULAE, GALAXIES, AND COSMOLOGY (3)
- 485. INTRODUCTION TO HIGH-ENERGY ASTRONOMY (3)
- 492. (E.E. 492) SPACE ASTRONOMY AND INTRODUCTION TO SPACE SCIENCE (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 510. ASTROPHYSICS I (3) The theory of atomic structure and spectra and the theory of equilibrium statistical mechanics with applications to astrophysical plasmas. Prerequisite: Phys. 410.
- 511. ASTROPHYSICS II (3) The theory of atomic processes and radiative transfer with and without the assumption of local thermodynamic equilibrium. Applications to astrophysics.
- 513. OBSERVATIONAL TECHNIQUES IN ASTRONOMY (3) Theoretical and practical aspects of modern observational astrophysics. Photometry, spectroscopy, stellar classification, detectors, space astronomy, and basic information theory. Prerequisite: Astro. 440.
- 514. OBSERVATIONAL PRACTICE (1-3) Practical experience with the observational research facilities, and with techniques of data acquisition and reduction.
- 524. CELESTIAL MECHANICS AND SPHERICAL ASTRONOMY (3) Two-body and one-body theory, elliptic motion, expansions, two-body orbit in space, coordinate transformations, planetary equations, Lagrange and Hamilton mechanics. Prerequisite: Astro. 460.
- 530. THEORY OF STELLAR ATMOSPHERES (3) Theory of photospheric structure, radiative processes, and line-formation in the outer layers of stars, and interpretation of stellar spectra. Prerequisite: Astro. 510.
- 531. THEORY AND ANALYSIS OF SPECTRAL LINES (3) The formation of spectral lines for both the LTE and NLTE cases, analysis of both line profiles and integrated intensities. Prerequisite: Astro. 530.
- 534. STELLAR STRUCTURE AND EVOLUTION (3) Theory of physical processes, structure, and evolutionary changes of stars; nature of intrinsic variable stars; the Hertzsprung-Russell diagram. Prerequisite: Astro. 510 or Phys. 561.
- 542. GASEOUS NEBULAE AND INTERSTELLAR MATTER (3) Theory and observations of galactic nebulae and interstellar medium, and problems related to the formation of stars. Prerequisite: Astro. 510.

550. HIGH-ENERGY ASTROPHYSICS (3) Theory and observations of X-rays and gamma rays from stars, black holes, neutron stars, supernova remnants, and extragalactic objects. Prerequisites: Phys. 400; Phys. 410 or 454.
582. RADIO ASTRONOMY (3) Methods of radio astronomy and its contribution to modern astrophysics. Galactic and extragalactic sources, using line, continuum, and interferometric observations. Prerequisite: Astro. 440.
583. GALAXIES, QUASARS, AND COSMOLOGY (3) Structure and population of the Milky Way galaxy, properties of galaxies, properties and nature of quasars, distance scale, and deceleration parameter. Prerequisite: Astro. 582.
590. COLLOQUIUM (1-3) Continuing seminars which consist of a series of individual lectures by faculty, students, or outside speakers.
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## BIOCHEMISTRY (BIOCH)

ALLEN T. PHILLIPS, *In Charge of Graduate Programs in Biochemistry*  
408 Althouse Laboratory  
814-865-1247

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Nathan N. Aronson, Jr., Ph.D. (Duke) *Associate Professor of Biochemistry*  
Robert W. Bernlohr, Ph.D. (Ohio State) *Professor of Biochemistry*  
Roy H. Hammerstedt, Ph.D. (Minnesota) *Associate Professor of Biochemistry*  
Wesley C. Hymer, Ph.D. (Wisconsin) *Professor of Biochemistry*  
Walter W. Karakawa, Ph.D. (Iowa) *Associate Professor of Biochemistry*  
Richard L. McCarl, Ph.D. (Penn State) *Professor of Biochemistry*  
John H. Pazur, Ph.D. (Iowa State) *Professor of Biochemistry*  
Allen T. Phillips, Ph.D. (Michigan State) *Professor of Biochemistry*  
Rosemary S. Schraer, Ph.D. (Syracuse) *Professor of Biochemistry*  
James W. Shigley, Ph.D. (Penn State) *Professor of Biochemistry*  
Frederick C. Wedler, Ph.D. (Northwestern) *Associate Professor of Biochemistry*

### Associate Members of the Graduate Faculty

Ross C. Hardison, Ph.D. (Iowa) *Assistant Professor of Biochemistry*  
Kenneth A. Johnson, Ph.D. (Wisconsin) *Assistant Professor of Biochemistry*  
Chen-Pei David Tu, Ph.D. (Cornell) *Assistant Professor of Biochemistry and Molecular Biology*

The graduate program in Biochemistry provides training for students in the principal areas of modern biochemistry and concurrently allows each student to develop expertise in a specific area of research plus acquire teaching experience at the undergraduate level. The program includes opportunities for research in intermediary metabolism and cellular control mechanisms, biochemical genetics, enzyme structure, kinetics and mechanisms, biochemical endocrinology, glycoprotein metabolism, microfilament structure and assembly, membrane biochemistry, heart cell culture, biochemistry of reproduction, mammalian gene structure, transposable elements and plasmids, immunochemistry and structure of cell surface antigens. Facilities for these research areas are extensive and permit investigations which are at the forefront of current biochemical research.

Because the Biochemistry graduate program is associated administratively with the graduate programs in Microbiology and Molecular and Cell Biology, interaction with these areas is frequent through joint seminar programs, common research interests, and shared facilities for research.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for*



*graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Admission to the program is competitive and is based on evaluations by the admissions committee of the applicant's performance in other degree programs, of Graduate Record Examination scores, and personal recommendations. Admission may be granted for a master's program only, or directly to the doctoral program.

Entering graduate students are expected to have had the equivalent of one year's work in each of the following: general chemistry, analytical chemistry, organic chemistry, physical chemistry, general physics, calculus, and biology. Students with limited deficiencies in these subjects may be admitted but must make up such deficiencies concurrently with their graduate studies. Undergraduate courses in biochemistry and a foreign language are desirable but are not required for admission.

Immediately prior to registration in the first semester of residence, students take American Chemical Society examinations in analytical, organic, physical, and biochemistry to permit a more complete judgment of the student's capabilities in these areas and to assist the general adviser in designing class schedules for new students until a thesis adviser has been selected. Although these achievement examinations are not part of the admissions process as such, they are required of all students entering the program, whether M.S. or Ph.D. candidates.

### **Master's Degree Requirements**

Students who wish to obtain the M.S. degree in Biochemistry must meet the minimum requirements set forth by the Graduate School. In addition, students are required to know one foreign language pertinent to biochemistry and equivalent to one year's study at the college level; to complete satisfactorily two written cumulative examinations taken from the series of ten such examinations required of M.S. and Ph.D. students; and to pass 12 credits at the 500 level, 6 of which must be in Biochemistry courses plus 2 credits of seminar. For this degree, all students must submit a thesis and defend it before a committee of the faculty. The research must represent an original contribution to biochemical knowledge, and the time allotted to it is generally equivalent to about one year of full-time work.

### **Doctoral Degree Requirements**

The Ph.D. program is designed to train independent research workers and scholars. Therefore, the research leading to a Ph.D. thesis is of fundamental importance to the training program. In addition to an intensive research experience, usually two to three years of laboratory work, students are required to complete the 9-credit sequence in Biochemistry at the 500 level; 12 credits outside the program at the 400 and 500 levels; and 4 credits of seminar. Students also are required to know one foreign language pertinent to biochemistry and equivalent to one year's study at the college level.

A decision regarding certification of the student for candidacy in the Ph.D. program is usually made soon after the student has completed 30 credits of course and thesis work. Certification is based on faculty recommendations, academic performance, teaching performance, and satisfactory completion of five of the ten monthly cumulative examinations required of all students.

A comprehensive oral examination is administered by the student's doctoral committee usually within three semesters after being admitted to candidacy. This examination is of a general nature but primarily emphasizes knowledge in the area pertaining to the thesis problem.

The faculty in Biochemistry also require each student to demonstrate the ability to collect, organize, and write the results obtained by research. This can be accomplished either by earning an M.S. degree in which a formal master's thesis is prepared or by preparing a manuscript written primarily by the student and accepted for publication in a refereed journal, the research for which must have been done by the student while enrolled in the graduate program. The choice between these two alternatives is made in consultation with the thesis adviser.

### **Other Relevant Information**

Students are encouraged to select a faculty thesis adviser early in their first year so as to begin their laboratory research program. The choice of adviser is based on mutual research interests as developed from special faculty research seminars presented to entering graduate students, personal interviews, and exploratory laboratory problems but may be restricted for reasons of maintaining balance among the research areas. Until students have chosen a research adviser, they are guided in selecting appropriate courses and in other matters by the general graduate adviser.

### **Student Aids**

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## BIOENGINEERING

### BIOCHEMISTRY (BIOCH)

- 401. GENERAL BIOCHEMISTRY (3)
- 402. GENERAL BIOCHEMISTRY (3)
- 403. EXPERIMENTAL BIOCHEMISTRY (3)
- 417. BIOCHEMICAL METHODS (6)
- 425. INTRODUCTORY PHYSICAL BIOCHEMISTRY (4)
- 437. PHYSIOLOGICAL BIOCHEMISTRY (3)
- 438. PHYSIOLOGICAL METHODS (2)
- 451. SENIOR SEMINAR (1)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 503. BIOCHEMICAL PROBLEMS (1-10 per semester) Prosecution of an assigned problem under the guidance of an instructor.
- 507. SEMINAR IN BIOCHEMISTRY (1 per semester)
- 514. (M.C.B. 514) MOLECULAR BIOLOGY AND CELLULAR REGULATION (3) Structure, synthesis, and biochemical properties of nucleic acids; protein biosynthesis; control of gene expression; molecular genetics. Prerequisite: Bioch. 402.
- 520. CARBOHYDRATES, LIPIDS, AND THEIR INTEGRATED METABOLISM (3) Chemistry of carbohydrates, lipids, and membranes; interrelationships between lipid and carbohydrate biosynthesis and metabolism. Prerequisite: Bioch. 402.
- 525. PROTEINS AND ENZYMES (3) Properties of proteins and polypeptides, structural analysis and molecular interactions; enzyme structure, kinetic mechanisms, and control. Prerequisite: Bioch. 402.
- 590. COLLOQUIUM (1-3)
- 597. SPECIAL TOPICS (1-9)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

### BIOENGINEERING (BIOE)

D. B. GESELOWITZ, *Chairman of the Program Committee in Bioengineering*  
254 Hammond Building  
814-865-1407

**Degrees Conferred:** Ph.D., M.S.

#### Senior Members of the Graduate Faculty

William S. Adams, Ph.D. (Penn State) *Professor of Electrical Engineering*  
Elsworth R. Buskirk, Ph.D. (Minnesota) *Professor of Applied Physiology*  
Steven J. Fonash, Ph.D. (Pennsylvania) *Professor of Engineering Science*  
David B. Geselowitz, Ph.D. (Pennsylvania) *Professor of Bioengineering and Medicine*  
Theodore M. Hollis, Ph.D. (Ohio State) *Associate Professor of Biology*  
Edward S. Kenney, Ph.D. (Penn State) *Professor of Nuclear Engineering*  
Donald E. Kline, Ph.D. (Penn State) *Professor of Materials Science*  
Gerard Lachs, Ph.D. (Syracuse) *Professor of Electrical Engineering*  
John B. Lewis, Ph.D. (Purdue) *Professor of Electrical Engineering*  
William S. Pierce, M.D. (Pennsylvania) *Professor of Surgery*  
M. G. Sharma, Ph.D. (Penn State) *Professor of Engineering Mechanics*  
John M. Tarbell, Ph.D. (Delaware) *Associate Professor of Chemical Engineering*  
James S. Ultman, Ph.D. (Delaware) *Professor of Chemical Engineering*  
William A. Weidner, M.D. (Wisconsin) *Professor of Radiology*  
Robert F. Zelis, M.D. (Chicago) *Professor of Medicine and Physiology*

#### Associate Members of the Graduate Faculty

Andris Freivalds, Ph.D. (Michigan) *Assistant Professor of Industrial Engineering*  
Roger P. Gaumond, D.Sc. (Washington) *Assistant Professor of Bioengineering*  
Arthur J. Liedtke, M.D. (Pittsburgh) *Professor of Medicine*  
Stephen H. Nellis, Ph.D. (Virginia) *Associate Professor of Medicine and Bioengineering*



Gerson Rosenberg, Ph.D. (Penn State) Assistant Professor of Bioengineering and Research Associate in Surgery

K. Kirk Shung, Ph.D. (Washington) Assistant Professor of Bioengineering

This intercollege program is designed to provide the student with graduate-level training in engineering and in the life sciences, and specialized training in specific areas of interaction of engineering with biology and medicine. Graduate instruction in bioengineering is under the direction of a program committee composed of graduate faculty representing several departments.

Opportunities for specialized research include electrical, mechanical, and ultrasonic properties of biological materials, development of an artificial heart, hemodynamics, electrocardiography, medical imaging, auditory electrophysiology, lung mechanics and pulmonary function, bioinstrumentation, transducers, and ultrasonics. Extensive computer facilities and specialized equipment are available to support these research activities.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Students with a degree in engineering, physics, or the life sciences will be eligible for admission. All students must have a strong background in physics and mathematics. This background should include 6 credits in chemistry, 9 credits in physics, and mathematics through calculus and differential equations. Students who lack one or two courses may still be considered for admission but will have to make up any deficiency early in their graduate program. Students with a 2.80 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces available. Exceptions to the minimum grade-point average may be made for students with special backgrounds, abilities, and interests.

### Master's Degree Requirements

The particular course of study depends on the student's background and area of research specialization. Courses are selected from the life sciences, engineering, and bioengineering. Course requirements include BioE. 401 and 402 plus two 500-level courses in bioengineering, 6 credits in the life sciences (including Biol. 472), and 6 credits in technically oriented courses outside of bioengineering and the life sciences. In addition, students without a previous degree in engineering or physics are required to complete up to 24 additional credits in engineering. Most of this additional course work will be at the undergraduate level and typically includes statics and dynamics, electric circuits and fields, electronic devices, fluid mechanics, and linear systems.

A thesis is required for the M.S. degree.

### Doctoral Degree Requirements

Candidates for the Ph.D. degree generally are expected to complete Phsio. (Biol.) 571-572 plus several additional courses in the life sciences, five courses in bioengineering, and five graduate-level courses in engineering, mathematics, and physics. Supporting courses are available at University Park and The Milton S. Hershey Medical Center in anatomy, biochemistry, biology, biophysics, chemistry, laboratory animal medicine, materials science, mathematics, physics, physiology, and the engineering departments.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by demonstrating intermediate knowledge of an acceptable foreign language, or by taking an advanced technical writing course and presenting a formal proposal for thesis research to the doctoral committee.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## BIOLOGICAL CHEMISTRY

### BIOENGINEERING (BIOE)

401. INTRODUCTION TO BIOENGINEERING (3)  
402. BIOMEDICAL INSTRUMENTATION AND MEASUREMENTS (3)  
425. (Nuc.E. 425) RADIOGRAPHIC IMAGING (3)  
496. INDEPENDENT STUDIES (1-18)  
497. SPECIAL TOPICS (1-9)
501. BIOENGINEERING TRANSPORT PHENOMENA (3) Application of the equations of mass, energy, and momentum conservation to physiological phenomena and to the design of artificial organs.  
502. INTRODUCTION TO BIOELECTRIC PHENOMENA (3) Electric phenomena in nerve and muscle, membrane potentials, Hodgkin-Huxley equations, volume conductor problem, applications to electrocardiography, electroencephalography, plethysmography.  
503. FLUID MECHANICS OF BIOENGINEERING SYSTEMS (3) Cardiovascular system and blood flow, non-Newtonian fluid description, vessel flows, unsteady flows and wave motion, windkessel theory, transmission line theory.  
504. PHYSIOLOGICAL SYSTEMS ANALYSIS (3) Application of systems theory, control theory, and analytic modeling strategies to the study of physiological systems. Prerequisites: Biol. 472, Math. 250.  
505. BIOENGINEERING MECHANICS (3) Passive and active mechanical properties of tissues, rheological materials, models of muscle contraction, pulmonary mechanics, forces in muscular-skeletal system.  
506. MEDICAL IMAGING (3) Medical diagnostic imaging techniques, including generation and detection of ultrasound, X-ray, and nuclear radiation; instrumentation and biological effects. Prerequisite: Phys. 202.  
507. BIOENGINEERING APPLICATIONS OF LABORATORY COMPUTERS (3) The organization of small laboratory computers and their use in real-time analysis of physiological data. Prerequisites: Bioe. 402, Cmp.Sc. 201.  
553. (I.E. 553) ENGINEERING OF HUMAN WORK (3) Physics and physiology of humans at work; models of muscle strength; dynamic movements; neural control; physical work capacity; rest allocation. Prerequisite: Biol. 41 or 472.  
570. TOPICS IN BIOMEDICAL INSTRUMENTATION (1) Physiological basis, theory of operation, and practical aspects of clinical instrumentation.  
580. BIOENGINEERING INTERNSHIP (3-6) Supervised experience at The Milton S. Hershey Medical Center, including rotation through services and work on a minor project. Prerequisites: Bioe. 402; 3 credits in Bioengineering at the 500 level.  
596. INDIVIDUAL STUDIES (1-9)  
597. SPECIAL TOPICS (1-9)

### BIOLOGICAL CHEMISTRY (BCHEM)

EUGENE A. DAVIDSON, *Chairman of the Department*  
The Milton S. Hershey Medical Center  
Hershey, PA 17033  
717-534-8585

**Degrees Conferred:** Ph.D., M.S.

#### Senior Members of the Graduate Faculty

Eugene A. Davidson, Ph.D. (Columbia) *Professor of Biological Chemistry*  
Louis F. Hass, Ph.D. (Duke) *Associate Professor of Biological Chemistry*  
Charles W. Hill, Ph.D. (Wisconsin) *Professor of Biological Chemistry*  
Mormilo Miljkovic, Ph.D. (Eidg. Technische Hochschule, Zürich) *Associate Professor of Biological Chemistry*  
Cara-Lynne Schengrund, Ph.D. (Seton Hall) *Associate Professor of Biological Chemistry*  
Ross Shiman, Ph.D. (California) *Associate Professor of Biological Chemistry*



**Associate Members of the Graduate Faculty**

V. P. Bhavanandan, Ph.D. (Edinburgh) *Associate Professor of Biological Chemistry*  
 Anita K. Hopper, Ph.D. (Illinois) *Associate Professor of Biological Chemistry*  
 James E. Hopper, Ph.D. (Wisconsin) *Associate Professor of Biological Chemistry*  
 George D. Rose, Ph.D. (Oregon State) *Associate Professor of Biological Chemistry*

Opportunities for research and graduate study are available in the chemistry and metabolism of complex polysaccharides, cellular differentiation, mechanism of enzymatic reactions, biochemical genetics, biochemistry of complex lipids, conformational analysis of carbohydrates and proteins, natural product chemistry, and physical chemistry of macromolecules.

The program is offered only at The Milton S. Hershey Medical Center.

**Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. Interested students should contact the department chairman.

**Degree Requirements**

The nonthesis option is available for the M.S. degree. The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of one foreign language.

**Student Aids**

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

**BIOLOGICAL CHEMISTRY (BCHEM)**

502. BIOLOGICAL CHEMISTRY I (3) Structure-function relationships of macromolecules; pathways utilized for energy generation in mammalian systems; concepts of metabolic regulation. Concurrent: Micrb. 556.

503. NUCLEIC ACID BIOCHEMISTRY (2) Aspects of the mechanism and control of nucleic acid and protein biosynthesis, with emphasis on their relationship to genetic phenomena. Prerequisite: Micrb. 556.

505. BIOLOGICAL CHEMISTRY II (3) A continuation of B.Chem. 502. Emphasis on interrelations of metabolic pathways, catabolic end products, and regulation. Prerequisites: B.Chem. 502, Micrb. 556.

513. BIOLOGICAL CHEMISTRY, MACROMOLECULES (3) Physical chemistry of macromolecules; techniques for investigating conformations, size, and interactions. Development and application of thermodynamics to solutions of macromolecules.

523. METABOLISM (3) Molecular mechanisms employed by living systems to transform biological compounds, control production and utilization of energy, and regulate metabolic pathways.

551. KINETICS AND MECHANISM OF ENZYME ACTION (3) Current kinetic theory, rapid reactions, regulatory enzymes, chemical and physical approaches to the study of the mechanism of enzyme action. Prerequisite: B.Chem. 502. Concurrent: B.Chem. 523.

553. BIOCHEMICAL TECHNIQUES (3) Lectures and discussion on approaches to macromolecule and lipid separation and characterization; isolation of subcellular organelles; enzymatic assay; radioisotopes. Prerequisite: B.Chem. 502.

590. COLLOQUIUM (1-3)

## BIOLOGY

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

## BIOLOGY (BIOL)

E. S. LINDSTROM, *Head of the Department*  
208 Erwin W. Mueller Building  
814-865-4562

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Adam Anthony, Ph.D. (Chicago) *Professor of Zoology*  
Edward D. Bellis, Ph.D. (Minnesota) *Professor of Biology*  
William A. Dunson, Ph.D. (Michigan) *Professor of Biology*  
C. Leonard Fergus, Ph.D. (Penn State) *Professor of Botany*  
Hannon B. Graves, Ph.D. (Virginia Polytech.) *Professor of Poultry Science*  
Paul Grun, Ph.D. (Cornell) *Professor of Cytology and Cytogenetics*  
Robert H. Hamilton, Ph.D. (Michigan State) *Professor of Biology*  
Emerson Hibbard, Ph.D. (Michigan) *Professor of Biology*  
Charles J. Hillson, Ph.D. (Penn State) *Professor of Botany*  
Theodore M. Hollis, Ph.D. (Ohio State) *Associate Professor of Biology*  
Carl S. Keener, Ph.D. (North Carolina State) *Associate Professor of Biology*  
David L. Pearson, Ph.D. (Washington) *Associate Professor of Biology*  
Ronald A. Pursell, Ph.D. (Florida State) *Professor of Botany*  
William Spackman, Ph.D. (Harvard) *Professor of Paleobotany*  
C. Dale Therrien, Ph.D. (Texas) *Associate Professor of Biology*  
Alfred Traverse, Ph.D. (Harvard) *Professor of Palynology*  
Edward W. Wickersham, Ph.D. (Wisconsin) *Associate Professor of Biology*  
Frederick M. Williams, Ph.D. (Yale) *Associate Professor of Biology*  
James E. Wright, Jr., Ph.D. (Cornell) *Professor of Genetics*

### Associate Members of the Graduate Faculty

John E. Burris, Ph.D. (California) *Assistant Professor of Biology*  
Christine M. Gregg, Ph.D. (Michigan) *Assistant Professor of Biology*  
Robert B. Mitchell, Ph.D. (Penn State) *Associate Professor of Biology*  
William H. Neff, Ph.D. (Penn State) *Associate Professor of Biology*  
Robert M. Petters, Ph.D. (North Carolina State) *Assistant Professor of Biology*  
Andrew G. Stephenson, Ph.D. (Michigan) *Assistant Professor of Biology*  
James B. Turpen, Ph.D. (Tulane) *Assistant Professor of Biology*

The department will direct graduate programs in behavior, cell biology, cytology, cytochemistry, environmental science, ultrastructure, zoology, and other aspects of modern biology. The courses of study are planned individually by the student and an adviser.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Admission is restricted to students who have the baccalaureate degree in a biological science and who present a cumulative undergraduate average of at least 3.00. Each applicant must provide scores from the Graduate Record Examination, a personal statement of interests and objectives, and letters from three persons verifying the applicant's academic competence.

### Degree Requirements

The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of one foreign language.



**Student Aids**

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following award typically has been available to graduate students in this program:

NATIONAL INSTITUTE OF AGING TRAINEESHIPS — Available to doctoral students in selected graduate programs for research training in adult development and aging; stipend varies. Details available from the Gerontology Center, S-211 Henderson Human Development Building.

**BIOLOGY (BIOL)**

- 402. VERTEBRATE NEUROANATOMY (3)
  - 407. PLANT ANATOMY (3)
  - 409. BIOLOGY OF AGING (3)
  - 414. TAXONOMY OF SEED PLANTS (3)
  - 417. INVERTEBRATE ZOOLOGY (4)
  - 418. MYCOLOGY (3)
  - 420. (Geosc. 420) PALEOBOTANY (3)
  - 421. COMPARATIVE ANATOMY OF VERTEBRATES (4)
  - 422. ADVANCED GENETICS (3)
  - 423. (Geosc. 423) INTRODUCTORY PALYNOLOGY (3)
  - 426. INTRODUCTORY CYTOGENETICS (3)
  - 427. (Geosc. 427) EVOLUTION (3)
  - 428. POPULATION GENETICS (3)
  - 429. DEVELOPMENTAL GENETICS (3)
  - 431. COMPARATIVE PLANT MORPHOLOGY (2)
  - 432. LABORATORY IN COMPARATIVE PLANT MORPHOLOGY (2)
  - 433. TERRESTRIAL ECOLOGY (3)
  - 434. TERRESTRIAL ECOLOGY LABORATORY (2)
  - 435. ECOLOGY OF LAKES AND STREAMS (3)
  - 436. FRESHWATER ECOLOGY RESEARCH TECHNIQUES (3)
  - 437. HISTOLOGY (4)
  - 438. ORNITHOLOGY (2)
  - 439. ORNITHOLOGY LABORATORY (2)
  - 440. EMBRYOLOGY (4)
  - 441. PLANT PHYSIOLOGY (3)
  - 442. PLANT PHYSIOLOGY (3)
  - 445. PHYTOHORMONES (3)
  - 446. PHYSIOLOGICAL ECOLOGY (3)
  - 447. TAXONOMY OF MOSSES AND FERNS (3)
  - 448. ECOLOGY OF PLANT REPRODUCTION (3)
  - 452. ICHTHYOLOGY (3)
  - 454. HERPETOLOGY (2)
  - 460. EMBRYONIC DIFFERENTIATION (3)
  - 462. (Pty.Sc. 462) ANIMAL BEHAVIOR—ETHOLOGY (3)
  - 463. (Pty.Sc. 463) ANIMAL BEHAVIOR—LABORATORY (1-2)
  - 464. (An.Sc. 464) ANIMAL BEHAVIOR — SOCIOBIOLOGY (3)
  - 465. GENERAL CYTOLOGY (3)
  - 466. LABORATORY IN CYTOLOGY (1)
  - 467. CYTOCHEMICAL METHODS (3)
  - 472. MAMMALIAN PHYSIOLOGY (3)
  - 473. LABORATORY IN MAMMALIAN PHYSIOLOGY (2)
  - 477. BIOLOGY OF HUMAN SEXUALITY (3)
  - 478. BIOLOGICAL AND MEDICAL ASPECTS OF THE MAMMARY GLAND (2)
  - 479. GENERAL ENDOCRINOLOGY (3)
  - 482. COASTAL BIOLOGY (4)
  - 496. INDEPENDENT STUDIES (1-18)
  - 497. SPECIAL TOPICS (1-9)
- 
- 502. THE PHYSIOLOGY OF THE FUNGI (3) Chemical composition, metabolism, toxic and stimulating agencies, spore germination, growth and irritability of the fungi.

504. (M.C.B. 504) SEMINAR IN CELL BIOLOGY (1) Discussion of current problems and ideas in cell biology, with emphasis on reference to recent literature.
506. COMPARATIVE ANATOMY OF VASCULAR PLANTS (2) Structure of the Tracheophyta from a phylogenetic standpoint. Prerequisite or concurrent: Biol. 407.
511. ADVANCED PLANT PHYSIOLOGY (3) Physiology of plants, including uptake of water and minerals, translocations, mineral nutrition, energy relations, respiration, and catabolism. Prerequisite: Biol. 422.
512. ADVANCED PLANT PHYSIOLOGY (3) Continuation of Biol. 511. Physiology of plants, including photosynthesis, synthesis of cellular constituents, growth and development. Prerequisite: Biol. 442.
514. TOPICS IN PLANT SYSTEMATICS AND EVOLUTION (1) Discussion of pertinent current literature in plant biosystematics.
516. TOPICS IN ANGIOSPERM GEOGRAPHY AND EVOLUTION (3) Distribution of plant communities; environmental factors which influence their present distribution; geological-historical development of plant communities, their past distribution.
517. FISH BEHAVIOR AS RELATED TO AQUATIC ECOLOGY (3) Receptor-effector systems, selection of habitat, and the effects of behavioral interaction on population levels, growth, and survival. Prerequisite: Biol. 452 or 462.
518. SPECIAL PROBLEMS (1-6) Prosecution of an assigned problem under the guidance of a staff member. Throughout the year as arranged. By appointment.
519. ZOOGEOGRAPHY (3) The present distribution of world vertebrates, their evolution, and their patterns of dispersal in the past.
522. LOWER FUNGI (3) Morphology, taxonomy, phylogeny, and life histories. Prerequisite: Biol. 418.
523. HIGHER FUNGI (3) Morphology, taxonomy, phylogeny, and life histories. Prerequisite: Biol. 418.
524. SEMINAR IN GENETICS (1 per semester)
526. (Geol. 526) PROBLEMS IN PALYNOLOGY (1-6) Individual research projects in various aspects of palynology, especially palynostratigraphy and paleoecological palynology. Prerequisite: Biol. 423.
527. (Stat. 527) QUANTITATIVE ECOLOGY (3) Introduction to quantitative population and community ecology, with emphasis on problems, concepts, and methods using mathematical, statistical, and computational analysis. Prerequisites: Biol. 210, Stat. (Math.) 409.
528. (Stat. 528) STATISTICAL ECOLOGY SPECTRUM (3) Overview of research and instruction of particular interest to quantitative ecology faculty in the Ecology program. Prerequisite: Biol. (Stat.) 527.
531. BRYOLOGY (3) Morphology, taxonomy, and ecology of liverworts, hornworts, and mosses; collection, preservation, culturing, and cytologic techniques.
533. PROBLEMS IN GENETICS (2-6) Problems to suit needs of individual students; conferences and laboratory work.
535. MORPHOLOGY OF THE TRACHEOPHYTA EXCLUSIVE OF ANGIOSPERMS (3) Origin, developmental tendencies, structure, and paleobotanical evidence.
536. MORPHOLOGY OF ANGIOSPERMS (3) Floral origin and development, fertilization, embryogeny, seeds and fruit development. Prerequisite: Biol. 431.
538. PRINCIPLES OF MICROSCOPIC HISTOCHEMISTRY (2) Theoretical basis for the microscopic identification, localization, and quantitative analysis of chemical substances in tissues of organisms. Prerequisite: Biol. 437 or 465.
539. ANALYTICAL HISTOCHEMISTRY LABORATORY (2-4) Application of histochemical techniques in the microscopic analysis of tissue lipids, proteins, carbohydrates, nucleic acids, and proteins. Prerequisite or concurrent: Biol. 538.



540. PHYCOLOGY (4) Comparative morphology, taxonomy, and ecology of freshwater and marine algae; culturing, collection, preservation techniques.
542. (Ent. 542) SYSTEMATICS (3) Principles and methods of classification, phylogeny, and speciation; taxonomic techniques, analysis of species; causal interpretation of animal diversity.
544. ADVANCED PHYSIOLOGICAL ECOLOGY (4) The physiological abilities of plants and animals to adapt to their abiotic environment.
545. ECOSYSTEM DYNAMICS (3) Survey and discussion of recent literature on ecosystem structure and function. Prerequisite: Biol. 210.
546. ECOLOGY OF POPULATION AND COMMUNITIES (3) Ecological laws governing population growth and decline; reproductive and mortality rates; predation and composition as limiting factors.
547. INVERTEBRATE BIOLOGY (3) Embryological development, metamorphosis, regeneration, and endocrinology of selected invertebrate groups (insects excluded). Invertebrate interactions and ecological impact.
550. NEUROGENESIS (2) Embryonic and evolutionary development of the nervous system. Determination, differentiation, orientation, and specificity of growing and regenerating nerve cells. Prerequisite: Biol. 440.
557. WORKSHOPS IN THE BIOLOGICAL SCIENCES (3) Projects designed for teachers of biology in the secondary schools.
571. (Phsio. 571) ANIMAL PHYSIOLOGY (2) Mammalian cardiovascular system; mammalian neurophysiology; excitable tissue, sensory systems, motor systems, and autonomic system. Prerequisite: Biol. 472.
572. (Phsio. 572) ANIMAL PHYSIOLOGY (2) Mechanisms involved in the activity and control of gastrointestinal function, respiration, and renal regulation of blood and body fluids. Prerequisite: Biol. 472.
573. (Phsio. 573) ANIMAL PHYSIOLOGY (2) Hypothalamic-hypophyseal relationships. Reproductive cycle regulation, endocrine control of fluid balance, body temperature, energy homeostasis, and metabolism of protein and minerals. Prerequisite: Biol. 472.
582. (Pty.Sc. 582, Psy. 582) RESEARCH IN ANIMAL BEHAVIOR (2-6 per semester) Research in special areas of animal behavior involving field or laboratory work.

## BOTANY (BOT)

E. S. LINDSTROM, *Head of the Department of Biology*  
208 Erwin W. Mueller Building  
814-865-4562

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

C. Leonard Fergus, Ph.D. (Penn State) *Professor of Botany*  
Paul Grun, Ph.D. (Cornell) *Professor of Cytology and Cytogenetics*  
Robert H. Hamilton, Ph.D. (Michigan State) *Professor of Biology*  
Charles J. Hillson, Ph.D. (Penn State) *Professor of Botany*  
Carl S. Keener, Ph.D. (North Carolina State) *Associate Professor of Biology*  
Ronald A. Pursell, Ph.D. (Florida State) *Professor of Botany*  
William Spackman, Ph.D. (Harvard) *Professor of Paleobotany*  
C. Dale Therrien, Ph.D. (Texas) *Associate Professor of Biology*  
Alfred Traverse, Ph.D. (Harvard) *Professor of Palynology*  
James E. Wright, Jr., Ph.D. (Cornell) *Professor of Genetics*

### Associate Members of the Graduate Faculty

John E. Burris, Ph.D. (California) *Assistant Professor of Biology*  
Andrew G. Stephenson, Ph.D. (Michigan) *Assistant Professor of Biology*

## BUSINESS ADMINISTRATION

Botanical programs are offered in plant anatomy, bryology, cytology, ecology, genetics, morphology, mycology, paleobotany, palynology, physiology, and taxonomy.

See also Genetics and Physiology.

For courses in Botany and related subjects see Biology.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

A student having a degree in science or in one of the biological sciences is eligible for admission. Entering graduate students should have had basic courses in chemistry, mathematics, and physics.

Admission is restricted to students who have the baccalaureate degree in a biological science and who present a cumulative undergraduate average of at least 3.00. Each applicant must provide scores from the Graduate Record Examination, a personal statement of interests and objectives, and letters from three persons verifying the applicant's academic competence.

### Degree Requirements

The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of one foreign language.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## BUSINESS ADMINISTRATION (B A)

MICHAEL P. HOTTENSTEIN, *Director of Graduate Programs in Business*  
106 Business Administration Building  
814-863-0474

**Degrees Conferred:** Ph.D., M.S., M.B.A.

### Senior Members of the Graduate Faculty

Sumer C. Aggarwal, Ph.D. (Moscow Ministry) *Professor of Management Science and Operations Management*

Robert M. Bear, Ph.D. (Iowa) *Associate Professor of Finance*

Leland L. Beik, Ph.D. (Columbia) *Professor of Marketing*

Peter D. Bennett, Ph.D. (Texas) *Professor of Marketing*

Stewart W. Bither, Ph.D. (Washington) *Professor of Marketing*

Joseph F. Bradley, Ph.D. (Pittsburgh) *Professor of Finance*

Joseph L. Carroll, D.B.A. (Indiana) *Professor of Business Logistics*

Joseph L. Cavinato, Ph.D. (Penn State) *Associate Professor of Business Logistics*

Kalyan Chatterjee, D.B.A. (Harvard) *Assistant Professor of Management Science*

John J. Coyle, D.B.A. (Indiana) *Professor of Business Administration*

Anthony J. Curley, Ph.D. (Pennsylvania) *Professor of Finance*

John D. Daniels, Ph.D. (Michigan) *Professor of Business Administration*

Samuel G. Davis, Ph.D. (Syracuse) *Assistant Professor of Management Science*

Mark W. Dirmsmith, Ph.D. (Northwestern) *Associate Professor of Accounting and Management Information Systems*

J. Russell Ezzell, Ph.D. (Penn State) *Professor of Finance*

William L. Ferrara, Ph.D. (Michigan State) *Professor of Accounting*

Paul S. Greenlaw, Ph.D. (Syracuse) *Professor of Management*

J. D. Hammond, Ph.D. (Pennsylvania) *William Elliott Professor of Insurance*

Jack C. Hayya, Ph.D. (U.C.L.A.) *Professor of Management Science*

George J. Heitmann, Ph.D. (Princeton) *Professor of Management Science*

Benjamin N. Henszey, M.L.T. (Georgetown) *Professor of Business Law*

Michael P. Hottenstein, D.B.A. (Indiana) *Professor of Management*

Stephen F. Jablonsky, Ph.D. (Illinois) *Associate Professor of Accounting and Management Information Systems*



Eugene J. Kelley, Ph.D. (New York) *Research Professor of Business Administration*  
 J. Edward Ketz, Ph.D. (Virginia Polytechnic) *Assistant Professor of Accounting and Management Information Systems*  
 George B. Kleindorfer, Ph.D. (Carnegie-Mellon) *Associate Professor of Management Science*  
 Gary A. Kochenberger, D.B.A. (Colorado) *Professor of Management Science*  
 Ronald S. Koot, Ph.D. (Oregon) *Professor of Management Science*  
 Gary L. Lilien, D.E.S. (Columbia) *Research Professor of Management Science*  
 Robert E. Malcom, Ph.D. (Ohio State) *Professor of Accounting and Management Information Systems*  
 James H. Miller, Ph.D. (Penn State) *Associate Professor of Business Logistics*  
 Stephen J. Motowidlo, Ph.D. (Minnesota) *Associate Professor of Organizational Behavior*  
 Jerry C. Olson, Ph.D. (Purdue) *Associate Professor of Marketing*  
 J. Keith Ord, Ph.D. (London) *Professor of Management Science*  
 Robert D. Pashek, Ph.D. (Illinois) *Professor of Business Administration*  
 Robert A. Pitts, D.B.A. (Harvard) *Associate Professor of Business Administration*  
 Srikanth Rao, Ph.D. (Penn State) *Associate Professor of Business Logistics*  
 Edward T. Reutzel, Ph.D. (Penn State) *Associate Professor of Management Science*  
 Paul H. Rigby, Ph.D. (Texas) *Professor of Business Administration*  
 William J. Schrader, Ph.D. (Washington) *Professor of Accounting and Management Information Systems*  
 Arnold F. Shapiro, Ph.D. (Pennsylvania) *Associate Professor of Business Administration*  
 Ned Shilling, Ph.D. (Columbia) *Professor of Quantitative Business Analysis*  
 Henry P. Sims, Jr., Ph.D. (Michigan State) *Professor of Organizational Behavior*  
 Charles C. Snow, Ph.D. (California) *Associate Professor of Organizational Behavior*  
 John C. Spychalski, D.B.A. (Indiana) *Professor of Business Administration*  
 Alan J. Stenger, Ph.D. (Minnesota) *Associate Professor of Business Logistics*  
 Gerald I. Susman, Ph.D. (U.C.L.A.) *Professor of Organizational Behavior*  
 James B. Thies, Ph.D. (Northwestern) *Associate Professor of Accounting and Management Information Systems*  
 John E. Tyworth, Ph.D. (Oregon) *Associate Professor of Business Logistics*  
 David T. Wilson, Ph.D. (Western Ontario) *Professor of Marketing*

#### **Associate Members of the Graduate Faculty**

Michel G. Bougon, Ph.D. (Cornell) *Assistant Professor of Organizational Behavior*  
 Daniel J. Brass, Ph.D. (Illinois) *Assistant Professor of Organizational Behavior*  
 Donald R. Chambers, Ph.D. (North Carolina) *Assistant Professor of Finance*  
 Philip L. Cochran, Ph.D. (Washington) *Assistant Professor of Business Administration*  
 Dennis A. Gioia, D.B.A. (Florida State) *Assistant Professor of Organizational Behavior*  
 Barbara G. Gricar, Ph.D. (Case Western Reserve) *Assistant Professor of Organizational Behavior*  
 Austin J. Jaffe, Ph.D. (Illinois) *Associate Professor of Business Administration*  
 William A. Kelly, Jr., Ph.D. (North Carolina) *Assistant Professor of Finance*  
 Robert W. Koehler, Ph.D. (Michigan State) *Associate Professor of Accounting*  
 Thomas W. Leigh, D.B.A. (Indiana University) *Assistant Professor of Marketing*  
 Kenneth M. Lusht, Ph.D. (Georgia State) *Associate Professor of Business Administration*  
 Andrew D. Luzi, Ph.D. (Kansas) *Assistant Professor of Accounting and Management Information Systems*  
 H. LeRoy Marlow, Ed.D. (Cornell) *Professor of Management Development*  
 Eugene R. Melander, Ph.D. (Minnesota) *Professor of Quantitative Business Analysis*  
 R. William Millman, Ph.D. (Florida) *Professor of Business Administration*  
 Barry L. Myers, J.D. (Boston Law) *Associate Professor of Business Law*  
 Alfred J. Nanni, Jr., Ph.D. (Massachusetts) *Assistant Professor of Accounting and Management Information Systems*  
 G. Kenneth Nelson, Ph.D. (Illinois) *Professor of Accounting and Management Information Systems*  
 Douglas Nigh, Ph.D. (U.C.L.A.) *Assistant Professor of International Business*  
 Reed T. Phalan, J.D. (Michigan Law) *Professor of Business Law*  
 Arno J. Rethans, Ph.D. (Oregon) *Assistant Professor of Marketing*  
 Heikki Rinne, Ph.D. (Purdue) *Assistant Professor of Marketing*  
 John L. Swasy, Ph.D. (U.C.L.A.) *Assistant Professor of Marketing*  
 Ronald J. Teichman, Ph.D. (Northwestern) *Assistant Professor of Accounting and Management Information Systems*  
 Richard D. Twark, Ph.D. (Penn State) *Associate Professor of Quantitative Business Analysis*  
 Arthur L. Williams, Ph.D. (Pennsylvania) *Professor of Insurance*  
 Robert A. Wood, Ph.D. (Pittsburgh) *Assistant Professor of Finance*  
 J. Randall Woolridge, Ph.D. (Iowa) *Assistant Professor of Finance*

The Master of Business Administration, M.B.A., is a professional degree designed to prepare individuals for managerial positions in business, government, and nonprofit institutions. The curriculum blends technical rigor, managerial theory, and integrative learning experiences through case studies

and other teaching methods. A managerial communications course is fully integrated into the program.

The Master of Science in Business Administration Program is highly flexible and designed for advanced study in a specialized field. The M.S. program is directed toward the development of competency within a defined area of management. Fields such as accounting, business logistics, finance, marketing, personnel, human resources management, management information systems, and management science are examples of career opportunities requiring specialized knowledge and skill, including research.

The Doctor of Philosophy in Business Administration Program offers advanced graduate education for students contemplating careers in academic teaching and research and research in nonuniversity settings. The faculty of the college views the Ph.D. as evidencing scholarship at the highest level.

### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in the program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Rather than the Graduate Record Examination (GRE), applicants to any of the graduate programs in Business Administration are required to take the Graduate Management Admission Test (GMAT), which is administered by the Educational Testing Service four times a year. For dates, locations, and other information on the test, write for the *Bulletin of Information*, Graduate Management Admission Test, Educational Testing Service, Princeton, NJ 08540.

Criteria for evaluating applicants include professional and academic accomplishments, GMAT scores, recommendations, and personal data from application forms which provide indications of future academic and professional accomplishment.

Work on the M.B.A. degree may be started fall semester only. M.S. and Ph.D. candidates may begin either the fall or spring semester. Individuals of all undergraduate disciplines are encouraged to apply.

While admission to the doctoral program does not require the applicant to hold a master's degree, this is ordinarily the case.

### **Master's Degree Requirements**

The M.B.A. program consists of two distinct portions: (1) preprogram competency expectations, including accounting, economics, mathematics, and statistics; and (2) 54 credits of graduate courses and a professional paper. Individuals who did not have adequate preparation in accounting, economics, mathematics, and statistics in their undergraduate programs can develop the required minimum level of competency through the use of self-teaching guides available through the graduate office in business administration. This competency must be developed before graduate study can begin. The time required to complete this graduate program, based on full-time study, is twenty-one months. The student body is divided into diverse sections of approximately forty students, with each section proceeding through the same core classes each semester. Emphasis is placed on student interaction and shared learning both inside and outside the classroom.

The M.S. program consists of two distinct portions: (1) approximately 33 acceptable undergraduate foundation credits in business administration, economics, and mathematics; and (2) 30 graduate credits in business administration or related areas, including a thesis. An applicant may be admitted without foundation courses, but they must be made up without degree credit. A professional paper and 6 additional credits of graduate-level course work can be substituted for the thesis. The time required to complete the graduate portion of this program, based on full-time study, is twelve months.

### **Doctoral Degree Requirements**

*Common Degree Requirements:* Breadth of understanding is gained from the common requirements, usually completed prior to undertaking the field requirements. To achieve breadth, all Ph.D. candidates exhibit competence in the following areas as ordinarily attained by completion of courses carrying graduate credit: accounting, 3 credits; quantitative business analysis, 6 credits; finance, 3 credits; marketing, 3 credits; management, 3 credits; economic theory (macro and micro), 6 credits. In addition, competence in differential and integral calculus (equivalent of 6 credits) and computer programming (3 credits) at graduate or undergraduate levels is required. Each candidate also is required to



achieve a level of competence in the application of quantitative analysis and behavioral science appropriate to doctoral work in his or her primary field in business administration.

**Language and Communication Requirements:** In addition to English competency, language and communication adequacy must be demonstrated by two of the following: (1) a reading knowledge of a foreign language; (2) behavioral science competence; (3) quantitative analysis competence; or (4) a second foreign language. The quantitative option is automatically incorporated in the common requirements subject to approval (as are all options) by the candidate's doctoral committee.

**Primary Field Requirements:** Each candidate is required to advance beyond the common requirement in a specialized field of business administration. The primary field is that sphere of scholarship which commands the most extensive and intensive portion of a program of study. It is in this area in which the dissertation research and major professors are selected. Primary fields can be selected from the following: Accounting, Business Logistics, Finance, Insurance, Management Science/Operations Management, Marketing, Organizational Behavior. Applicants to the program must select a primary field of specialization to complete the admission process, since faculty committees in each of the fields make the admission decisions.

**Supporting Field Requirements:** Each candidate must select two supporting fields of study from business administration and/or from related areas. These spheres of scholarship complement the candidate's primary field. Ordinarily, one supporting field would be from business administration and one outside business administration. Supporting fields from business administration include all those listed above under primary fields plus International Business. Outside supporting fields include anthropology, computer science, economics, industrial engineering, mathematics, political science, psychology, sociology, and statistics.

**The Dissertation:** The major requirement of the Ph.D. program in Business Administration is the doctoral dissertation. Each candidate conceptualizes, designs, and executes a significant research project as his or her dissertation and presents the findings in an acceptable written form.

#### **Other Relevant Information**

The College of Business Administration, in cooperation with the Department of French, offers concurrent master's degree programs in French Studies and in Business Administration to provide training in both business and French studies for students who plan a career in international business. For details of the programs, see the description of the graduate program in French. The college also offers work/study abroad programs in France, Germany, and Peru.

#### **Student Aids**

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

**AMERICAN ACCOUNTING ASSOCIATION FELLOWSHIP** — Available to a Ph.D. candidate in accounting; stipend variable up to \$1,000 per year.

**AMERICAN INSTITUTE OF CERTIFIED PUBLIC ACCOUNTANTS FELLOWSHIP** — Available to a Ph.D. candidate in accounting; stipend variable up to \$600 monthly, or \$700 monthly with dependents (maximum of twelve months).

**ARTHUR ANDERSON & CO. FOUNDATION FELLOWSHIP** — Available to a Ph.D. candidate in accounting; stipend variable up to \$7,800 (distributed monthly — maximum of twelve months).

**COOPERS & LYBRAND FOUNDATION FELLOWSHIP** — Available to a Ph.D. candidate in accounting; stipend variable, up to \$5,000.

**ERNST AND WHINNEY FELLOWSHIP** — Available to a master's candidate in accounting, stipend \$1,000; to a Ph.D. candidate with stipend up to \$7,800 (distributed monthly — maximum of twelve months).

**HASKINS AND SELLS FOUNDATION FELLOWSHIP** — Available to a Ph.D. candidate in accounting after candidate's first academic year; stipend in two parts: \$4,000 (last twelve months of course work) and \$8,000 (twelve months during dissertation stage).

**WALTER E. HELLER FELLOWSHIP** — Provided by Walter E. Heller & Company, in the amount of \$1,000 for a candidate for the degree of Master of Business Administration.

**PRICE WATERHOUSE FOUNDATION FELLOWSHIP** — Available to a Ph.D. candidate in accounting; stipend variable.

## BUSINESS ADMINISTRATION

**SHAEFFER SCHOLARS PROGRAM** — Provided by Charles W. Shaeffer ('33), retired board chairman, T. Rowe Price Associates, to M.B.A. candidates evidencing strong academic and managerial potential; stipend \$4,000. Apply to director of M.B.A. program.

**ARTHUR YOUNG AND COMPANY FELLOWSHIP** — Open to a master's degree candidate in accounting from a predominantly black college. Contact the department in the College of Business Administration.

### ACCOUNTING (ACCTG)

- 400. FINANCIAL ACCOUNTING I (5)
- 401. FINANCIAL ACCOUNTING II (4)
- 403. AUDITING (4)
- 404. MANAGERIAL ACCOUNTING (4)
- 406. ADVANCED FEDERAL TAXATION (3)
- 413. AUDITING INTERNSHIP (3)
- 414. MANAGERIAL ACCOUNTING INTERNSHIP (3)
- 416. FEDERAL INCOME TAX FORM PREPARATION (1)
- 421. INTERNATIONAL ACCOUNTING (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 501. RESEARCH METHODS IN ACCOUNTING (3) An introduction to the methods and techniques of contemporary research in accounting. Prerequisites: Acctg. 504, 507, and a course in statistical inference.
- 503. SEMINAR IN AUDITING (3) The attest function of independent public accountants, verification of financial statements; problems of evidence, independence, ethics, professional responsibilities. Prerequisite: Acctg. 403.
- 504. SEMINAR IN MANAGERIAL ACCOUNTING (3-6) Accounting and the managerial processes of planning, control, and decision making.
- 507. SEMINAR IN FINANCIAL ACCOUNTING (3) Theoretical basis of financial accounting.
- 508. CONTEMPORARY ISSUES IN ACCOUNTING (3) Selected problems of current interest to the accounting profession.
- 511. FINANCIAL AND MANAGERIAL ACCOUNTING (3) Fundamental financial and managerial accounting concepts and issues from the viewpoint of the report user.
- 512. FINANCIAL ACCOUNTING THEORY AND REPORTING PROBLEMS (3) Measurement and reporting of financial information for external purposes, with particular attention to current problems in asset and income measurement. Prerequisite: Acctg. 511.
- 514. SEMINAR IN FEDERAL TAXATION (3) The federal tax structure, including legal, economic, and government implications; focusing on business decisions, research methodology, and tax planning.
- 515. DEVELOPMENT OF ACCOUNTING THOUGHT (3) Development of accounting thought from ancient civilizations to the present.
- 516. SEMINAR IN NOT-FOR-PROFIT ACCOUNTING (3) Measurement and structuring of financial information for managerial planning and control and external reporting.
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

### BUSINESS ADMINISTRATION (B A)

- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
- 499. FOREIGN STUDY — BUSINESS ADMINISTRATION (2-6)



503. SEMINAR IN PUBLIC UTILITIES (3)

517. COMMUNICATION SKILLS FOR MANAGEMENT (1-3) Development of communication skills required for management; audience awareness, style, individual and group presentations. Prerequisite: admission to the Master of Business Administration program.

533. PRICES AND MARKETS (3) A survey of analytical concepts and techniques essential to an understanding of the business environment.

555. BUSINESS AND SOCIETY (3) Evolution of the business organization and the changing framework of its operations, responsibilities, and social control.

560. ENTERPRISE CONSULTING (3) Student groups engaging in consulting relationships with enterprises through use of managerial techniques for identification, analysis, and solution of managerial problems. Prerequisites: Acctg. 511; B.A. 555; Econ. 500; Mgmt. 501; Q.B.A. 510, 511.

574. BUSINESS RESEARCH (1-3) A project paper, comparable in quality and scope of work to a graduate thesis, on problems of a company. Prerequisite: 15 credits of 400- and 500-level courses in business administration.

578. ENTREPRENEURSHIP (3) Study of the development or acquisition of a business appropriate to the objectives and resources of the individual entrepreneur.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

**BUSINESS LAW (B LAW)**

400. REAL ESTATE LAW (3)

410. CRIMINAL LAW AND PROCEDURE IN THE BUSINESS COMMUNITY (3)

420. CRIMINAL PROCEDURE AND EVIDENCE IN THE BUSINESS COMMUNITY (3)

445. BUSINESS AND THE PUBLIC LAW (3)

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

**BUSINESS LOGISTICS (B LOG)**

400. TRANSPORT PLANNING ANALYSIS (3)

405. WAREHOUSING AND TERMINAL MANAGEMENT (3)

410. TRANSPORT ECONOMICS AND POLICY (3)

415. LOGISTICS SUPPLY MANAGEMENT (3)

420. URBAN TRANSPORTATION (3)

425. LOGISTICS SYSTEMS MANAGEMENT (3)

430. TRANSPORT PROBLEMS (3)

455. INTERNATIONAL LOGISTICS (3)

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

538. LOGISTICS SYSTEMS MANAGEMENT (3) Control of the movement of goods; coordination of supply and demand in creation and maximization of time and place utility.

540. TRANSPORT POLICY (3) Role of transport in the economy. Transport systems elements, development, cost, and pricing characteristics. Public control and public policies.

541. SOCIOECONOMIC ANALYSIS IN TRANSPORTATION (3) Role of transport in social and economic activity. Planning and coordination of transport systems. Designed for the traffic engineering program.

542. LOGISTICS AND TRANSPORT PLANNING (3) Techniques of analysis for public and private sector project and program decisions.

544. LOGISTICS AND TRANSPORT MANAGEMENT (3) Design of optimal strategies for transport and logistics systems management under varying internal and external conditions. Prerequisites: 6 credits in business logistics.

560. SEMINAR IN TRANSPORT ECONOMICS AND POLICY (3 per semester, maximum of 6) Comparative analysis of theoretical and empirical studies in transport cost, demand, pricing, and policy problems.

565. SEMINAR IN BUSINESS LOGISTICS (3-6)

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

### **FINANCE (FIN)**

405. CAPITAL BUDGETING (3)

406. SECURITY ANALYSIS AND PORTFOLIO MANAGEMENT (3)

408. FINANCIAL MARKETS (3)

410. SPECULATIVE MARKETS (3)

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

504. PROBLEMS IN FINANCE (3-6) Planned individual projects involving library, laboratory, or field work.

505. (I.B. 505) MULTINATIONAL MANAGERIAL FINANCE (3) Analysis of the international aspects of managerial finance. Emphasis on the environmental and institutional factors influencing capital acquisition and allocation. Prerequisite: Fin. 531.

506. PORTFOLIO THEORY AND POLICY (3) Rigorous examination and analysis of asset-holder behavior under conditions of risk and uncertainty.

508. ANALYSIS OF FINANCIAL MARKETS (3) Analysis of factors affecting price determination in financial markets.

510. CONTEMPORARY ISSUES IN FINANCIAL INSTITUTIONS (3) Critical investigation of problems of current interest in the market structure and internal operations of financial institutions.

531. FINANCIAL MANAGEMENT (3) An intensive examination of techniques available to aid the financial manager in decision making.

532. FINANCIAL DECISION PROCESSES (3) Financial decision making under uncertainty; positive and normative models and current issues in financial management.

541. SECURITY ANALYSIS (3) Discussion and application of analytical techniques in security valuation, including use of computers.

561. SEMINAR IN FINANCE (3-6) Comparative analysis of research in the theories of finance; relationships to business management practices.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

### **INSURANCE (INS)**

400. ESTATE PLANNING (3)

401. FUNDAMENTALS OF PRIVATE PENSIONS (3)

410. COMPOUND INTEREST AND ANNUITIES — CERTAIN (3)

411. LIFE CONTINGENCIES I (3)

412. LIFE CONTINGENCIES II (3)

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

500. MANAGEMENT OF THE INSURANCE ENTERPRISE (3) Management planning associated with risk bearing; pricing, reserving, reinsurance, and regulation; Lloyds and other significant world insurance markets; insurance intermediaries.



504. PROBLEMS IN INSURANCE (3) Planned individual projects involving library, laboratory, or field work.

510. RISK MANAGEMENT (3) Analysis of managerial problems and responsibilities of risk analysis, removal or reduction, and allocation of corporate resources to provide indemnity.

596. INDIVIDUAL STUDIES (1-9)

## **INTERNATIONAL BUSINESS (I B)**

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

500. INTERNATIONAL BUSINESS MANAGEMENT (3) Concepts and institutions affecting the international conduct of business; interface between nations and international firms; alternative policies businesses employ internationally.

501. COMPARATIVE BUSINESS SYSTEMS (3) Conceptual approach analyzing and predicting influences of social, political, and economic norms and values upon diverse societies' managerial decision making.

502. INTERNATIONAL BUSINESS MACRO ANALYSIS (3) International economic, trade, political, and monetary tools are applied to national policy issues and international business operations. Prerequisite: I.B. 500.

503. INTERNATIONAL BUSINESS POLICY (3) Analysis of the internal operations of multinational firms; design of optimal strategies of operation under varying environmental conditions. Prerequisite: I.B. 500.

504. SEMINAR IN INTERNATIONAL BUSINESS (3-6) Seminar in techniques applied to selected topics; market structures; capital budgeting, investment; comparisons of foreign norms and values; multinational organization characteristics.

505. (Fin. 505) MULTINATIONAL MANAGERIAL FINANCE (3) Analysis of the international aspects of managerial finance. Emphasis on the environmental and institutional factors influencing capital acquisition and allocation. Prerequisite: Fin. 531.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

## **MANAGEMENT (MGMT)**

401. CONTEMPORARY ISSUES IN MANAGEMENT (3)

423. ORGANIZATION CHANGE AND DEVELOPMENT (3)

424. INTERPERSONAL RELATIONSHIPS IN ORGANIZATIONS (3)

441. MANAGEMENT OF PERSONNEL SYSTEMS (3)

471. BUSINESS POLICY FORMULATION AND CONTROL (3)

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

501. BEHAVIORAL SCIENCE IN BUSINESS (3) Application of behavioral science concepts and analytical methods to problems in business organizations. Analysis of administrative behavior and decision making.

523. ORGANIZATIONAL CHANGE: THEORY AND PRACTICE (3) Analysis of research, theory, and practice in dynamics of organizational change. Research literature reviewed for evaluation of concepts and methods.

524. INTERPERSONAL RELATIONS IN ORGANIZATIONS (3) Development of skills and sensitivity for dealing with interpersonal relationships in complex organizations. Prerequisite: Mgmt. 501.

525. MANAGEMENT OF SOCIO-TECHNICAL SYSTEMS (3) Theories and methods for diagnosing problems of productivity and quality of working life in organizations; planning, implementing, and evaluating solutions.

## BUSINESS ADMINISTRATION

- 528. SEMINAR IN ORGANIZATIONAL BEHAVIOR (3) Current theoretical and research issues applicable to the study of individual and group behavior within organizational settings.
- 532. COMPLEX ORGANIZATIONS: STRUCTURE AND DESIGN (3) The design and management of complex organizations from a managerial perspective.
- 538. SEMINAR IN ORGANIZATION THEORY (3) Current theoretical and research issues applicable to the study of design and management of complex organizations.
- 541. PERSONNEL MANAGEMENT (3) Theory and practice of personnel management and analysis of personnel problems of relevance to all types of managers.
- 571. ADMINISTRATIVE INTEGRATION (3) An analysis of coordination of the functional areas of business in relation to overall company objectives.
- 575. FUTURE STUDIES AND MANAGERIAL PLANNING (3) Theory and research on the "future" dimensions of decision making and planning, particularly under conditions of rapid change.
- 576. PLANNING MODELS AND TECHNIQUES (3) Survey of models, concepts, and techniques appropriate to managerial long-range planning in complex organizations.
- 578. SEMINAR IN CORPORATE STRATEGY (3) Current theoretical and research issues applicable to the study of corporate strategy formulation and implementation.
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)

## MANAGEMENT INFORMATION SYSTEMS (M I S)

- 431. INTRODUCTORY MANAGEMENT INFORMATION SYSTEMS (4)
- 432. ACCOUNTING INFORMATION SYSTEMS (4)
- 433. COMPUTER AUDIT AND CONTROL (4)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 531. MANAGEMENT INFORMATION SYSTEMS (1-3) Information system theories and methods applied to administrative structures and management decisions in organizations.
- 537. (Cmp.Sc. 537) MANAGEMENT INFORMATION SYSTEMS DESIGN (3) Cost, value, and technical considerations in analysis and design of information systems whose purposes are to aid decision making in organizations.
- 538. INFORMATION SYSTEMS FOR PLANNING AND CONTROL (3) Analysis of information requirements for planning, decision making, and performance measurement in organizations.
- 539. SEMINAR IN MANAGEMENT INFORMATION SYSTEMS (3) Special topics selected from contemporary issues in management information systems.
- 590. M.I.S. COLLOQUIUM (1-3) This seminar will deal with current research areas dealing with the development and management of management information systems within organizations. Prerequisite: M.I.S. 531.
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)

## MARKETING (MKTG)

- 422. ADVERTISING AND SALES PROMOTION MANAGEMENT (3)
- 424. MARKETING RESEARCH PROJECTS (3)
- 426. INDUSTRIAL MARKETING (3)
- 428. SALES MANAGEMENT (3)
- 450. MARKETING MANAGEMENT POLICIES AND PROGRAMS (3)
- 490. ADVANCED BUYER BEHAVIOR (3)
- 495. QUANTITATIVE ANALYSIS FOR MARKETING MANAGEMENT (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)



500. **MARKETING MANAGEMENT (3)** Development of a marketing management focus, including market analysis, competition analysis, and decisions in pricing, product, promotion, and distribution channels.

510. **PLANNING MARKETING STRATEGY AND PROGRAMS (3)** Development of marketing strategy consistent with corporate plans, including integrated marketing mix programs based on environmental, customer, and competitive analysis. Prerequisite: Mktg. 500.

511. **QUANTITATIVE ANALYSIS FOR MARKETING DECISIONS (3)** Application of quantitative and analytical tools for marketing decisions in forecasting, new product development, advertising, promotions, pricing, and personal selling. Prerequisite: Mktg. 500.

512. **CONSUMER AND MARKET BEHAVIOR (3)** Application of buyer behavior concepts from the behavioral sciences, including utility, culture, life cycle, personality, attitudes, learning, decision making. Prerequisite: Mktg. 500.

513. **MARKET RESEARCH (3)** User-oriented analysis of marketing research process, including problem definition, design, data collection, data analysis, interpretation, and presentation. Prerequisite: Mktg. 500.

514. **MANAGEMENT OF MARKETING COMMUNICATIONS (3)** Management of advertising, sales promotion, and personal selling programs. Topics: segmentation; copy, media, budget decisions; sales territory; and management issues. Prerequisite: Mktg. 500.

551. **THEORETICAL PERSPECTIVES ON BUYER BEHAVIOR (3)** Review of marketing and social sciences research related to understanding consumer and market behavior.

552. **MARKETING THEORY (3)** Theory building in marketing; the intricate relation of theory and research.

553. **DEVELOPMENTS OF MARKETING THOUGHT (1)** Analysis of major contributions to the development of marketing thought.

554. **RESEARCH METHODS IN MARKETING (3)** Philosophical, methodological, and measurement issues involved in designing, conducting, analyzing, and interpreting research in marketing.

555. **MARKETING MODELS (3)** Topics in the model building approach to marketing decision making, focusing on current research issues.

596. **INDIVIDUAL STUDIES (1-9)**

597. **SPECIAL TOPICS (1-9)**

602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)**

## **OPERATIONS MANAGEMENT (OPMGT)**

415. **FACILITIES MANAGEMENT (3)**

416. **OPERATIONS PLANNING AND CONTROL (3)**

418. **MATERIALS MANAGEMENT (3)**

510. **OPERATIONS MANAGEMENT (3)** Integration and application of decision making to operational and policy problems within the business firm.

515. **DESIGN OF OPERATION OUTPUT SYSTEMS (3)** Examination of research-based findings in operations management, with a focus on the design and reliability of production systems.

516. **OPERATIONS PLANNING AND CONTROL (3)** Examination of research-based findings in operations management. The focus is on the operation and control of production systems.

518. **MANAGEMENT OF INVENTORY SYSTEMS (3)** Analysis of business organizations as integrated inventory systems. Inventory theory and model building as tools for management decision making. Prerequisite: Op.Mgt. 510 or Q.B.A. 561 or I.E. 509.

## **QUANTITATIVE BUSINESS ANALYSIS (Q B A)**

403. **STATISTICAL METHODS FOR BUSINESS DECISIONS (3)**

404. **SAMPLING IN BUSINESS OPERATIONS AND RESEARCH (3)**

427. **MANAGEMENT DECISION THEORY (3)**

432. **SIMULATION OF MANAGEMENT SYSTEMS (3)**

## BUSINESS ADMINISTRATION

- 451. LINEAR PROGRAMMING (3)
- 452. NONLINEAR PROGRAMMING (3)
- 461. PROBABILISTIC MODELS IN BUSINESS (3)
- 490. ADVANCED BUSINESS STATISTICS (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 500. SEMINAR IN BUSINESS STATISTICS (3-6)
- 501. ADVANCED BUSINESS STATISTICS (3)
- 510. STATISTICAL ANALYSIS FOR MANAGERIAL DECISION MAKING (3) Use of statistical methods for managerial decision making, with emphasis on problem formulation, data analysis and interpretation, and business applications. Prerequisites: 3 credits each in undergraduate accounting, economics, and statistics.
- 511. QUANTITATIVE ANALYSIS FOR BUSINESS DECISIONS (3) Construction and use of quantitative methods in business decision making. Prerequisite: common requirements of M.B.A. program.
- 527. ANALYSIS FOR DECISION MAKING UNDER UNCERTAINTY (3) Topics in decision making under uncertainty, including decision theory, Bayesian statistics; payoff function, including utility theory and multi-attribute measures.
- 532. MANAGEMENT SYSTEMS SIMULATION (3) Application of computer simulation to the analysis and design of management decision systems. Design of simulation experiments in business research. Prerequisite: 3 credits of computer programming.
- 533. REGRESSION ANALYSIS FOR BUSINESS DECISIONS (3) The development and use of regression models in the analysis of business decisions.
- 537. MULTIVARIATE ANALYSIS FOR BUSINESS DECISIONS (3) The development and use of multivariate statistical models in the analysis of business decisions.
- 540. MATHEMATICAL PROGRAMMING (3) Nonlinear programming and geometric programming, with emphasis on both theory and applications. Prerequisite: Q.B.A. 452.
- 550. SEMINAR IN MATHEMATICAL PROGRAMMING (3-6) Intensive treatment of theory and computational algorithms of mathematical programming; emphasis on operational application to complex management and business problems. Prerequisite: I.E. 510.
- 561. STOCHASTIC MODELS FOR MANAGEMENT DECISIONS (3) Introduction to stochastic processes in business organizations. Application of stochastic models to the conceptualization, analysis, and solution of management problems. Prerequisite: Math. (Stat.) 416.
- 565. MANAGERIAL FORECASTING (3) The use of time-series models, including exponential smoothing and Box-Jenkins (ARIMA) techniques for business and economic forecasting.
- 567. NONPARAMETRIC STATISTICS FOR BUSINESS ANALYSIS (3) The use of nonparametric statistical techniques in the analysis of business decisions.
- 570. MANAGEMENT SCIENCE: IMPLEMENTATION AND CONTROL (3) Development and application of management science models. Model formulation and specification, sensitivity analysis, problems encountered in implementation and control.
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)

## REAL ESTATE (R EST)

- 410. THE VALUATION OF REAL PROPERTY (3)
- 450. SEMINAR IN REAL ESTATE (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 510. REAL ESTATE FINANCIAL ANALYSIS (3) Real estate finance and investment analysis. Topics include housing, demand and supply of credit, and real estate investment strategies.



515. **URBAN LAND USE ISSUES (3)** Topics deal with current issues facing real estate owners, investors, lenders, developers, governments, and society.

596. **INDIVIDUAL STUDIES (1-9)**

597. **SPECIAL TOPICS (1-9)**

## CERAMIC SCIENCE (CERSC)

RICHARD E. TRESSLER, *In Charge of Graduate Programs in Ceramic Science*

201 Steidle Building

814-865-7961

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Richard C. Bradt, Ph.D. (Rensselaer) *Professor of Ceramic Science and Engineering*

Herbert A. McKinstry, Ph.D. (Penn State) *Associate Professor of Ceramic Science and Engineering*

Robert E. Newnham, Ph.D. (Penn State, Cambridge) *Professor of Solid State Science*

Guy E. Rindone, Ph.D. (Penn State) *Professor Emeritus of Ceramic Science and Engineering*

Karl E. Spear II, Ph.D. (Kansas) *Professor of Ceramic Science and Engineering*

Vladimir S. Stubican, Dr.Phil. (Zagreb), D.Sc. *Professor of Ceramic Science and Engineering*

Richard E. Tressler, Ph.D. (Penn State) *Professor of Ceramic Science and Engineering*

### Associate Members of the Graduate Faculty

Gary L. Messing, Ph.D. (Florida) *Assistant Professor of Ceramic Science and Engineering*

Carlo G. Pantano, Ph.D. (Florida) *Assistant Professor of Ceramic Science and Engineering*

*In addition to these faculty members, other Materials Science, Electrical Engineering, and Geoscience faculty members advise or co-advise Ceramic Science graduate students.*

This program is one of the options in which a graduate student in the Department of Materials Science and Engineering can receive an advanced degree. In view of the wide field covered by ceramic science, the graduate courses may be selected with special emphasis in ceramic processing, physical ceramics, chemical ceramics, or glass science.

Special facilities exist for research in the areas of electroceramics, ceramic processing, phase equilibria, solid-state synthesis, mechanical properties, ferrite and ferroelectric studies, glass science, surface characterization and properties, high-temperature reaction kinetics, and corrosion studies. Suitable preparation for graduate study in this program may be found in one of the material sciences, such as ceramics or metallurgy, in engineering fields such as chemical or mechanical engineering, in the basic physical sciences, or in the earth sciences.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in the program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

### Degree Requirements

The communication and foreign language requirement may be satisfied by (1) examinations in two languages or (2) examination in one foreign language and either 6 credits of computer science or 6 credits of statistics, or 3 credits of computer science and 3 credits of statistics.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid

## CERAMIC SCIENCE

described in the STUDENT AIDS section of the Graduate Bulletin, the following awards, with annually adjusted stipends, typically have been available to graduate students in this program:

**AIRCO SPEER FELLOWSHIP** — Available to a graduate student in ceramic science and engineering for research on carbon and graphite.

**CORNING FELLOWSHIP** — Available to a graduate student in ceramic science.

**DOLOMITE BRICK CORPORATION GRADUATE FELLOWSHIP** — Available to a graduate student in ceramic science and engineering for research on the thermal/mechanical behavior of dolomite refractories.

**INLAND STEEL FELLOWSHIP** — Available to a graduate student in ceramic science and engineering for research on coke and coal-derived material.

**KAISER FELLOWSHIP** — Available to a graduate student in ceramic science and engineering for research on borides and carbides.

**NORTH AMERICAN REFRACTORIES COMPANY FELLOWSHIP** — Available to a graduate student in ceramic science and engineering for research on refractories.

**OWENS-ILLINOIS FELLOWSHIP** — Available to a graduate student in ceramic science whose thesis is in the area of glass science and technology.

**TEXACO FELLOWSHIP IN EARTH AND MINERAL SCIENCES** — Available to a graduate student in the College of Earth and Mineral Sciences.

### CERAMIC SCIENCE AND ENGINEERING (CERSE)

- 400. NONMETALLIC CRYSTAL CHEMISTRY (2-3) *Newnham*
- 404. CERAMIC SEMINAR (1) *Bradt*
- 406. PROCESSING OF CERAMICS (3)
- 407. CERAMIC PROCESSING LABORATORY (1)
- 408. THERMAL PROPERTIES OF CERAMIC MATERIALS (2) *Spear*
- 409. REFRACTORIES AND THERMAL PROPERTIES (1)
- 410. PHASE RELATIONS IN CERAMIC SYSTEMS (3) *Spear*
- 411. REACTIONS IN CERAMIC SYSTEMS (3)
- 412. GLASS AND MECHANICAL PROPERTIES LABORATORY (1)
- 414. MECHANICAL PROPERTIES OF CERAMICS (2) *Bradt*
- 415. PRINCIPLES OF GLASS TECHNOLOGY (3) *Pantano*
- 420. REFRACTORIES (2) *Stubican*
- 430. ELECTRICAL, OPTICAL, AND MAGNETIC PROPERTIES (3)
- 431. ELECTRICAL, OPTICAL, AND MAGNETIC PROPERTIES (1)
- 496. INDEPENDENT STUDIES (1-18)

### CERAMIC SCIENCE (CERSC)

- 500. SEMINAR IN CERAMIC SCIENCE (1-2 per semester) Current developments in ceramic science and related fields. Required of all graduate students in Ceramic Science.
- 501. SURFACE BEHAVIOR OF CERAMIC MATERIALS (2-4) Surface chemistry of ceramics. Rheology of ceramic powders, suspensions, and pastes. *Messing*
- 502. MECHANICAL PROPERTIES OF CERAMICS I (2) Theoretical considerations of the crystallographic and microstructural aspects of the elastic properties and fracture characteristics of ceramics. Prerequisite: Cer.S.E. 414 or E.Mch. 415. *Bradt*
- 504. SOLID STATE REACTIONS IN CERAMIC SYSTEMS (2) Thermodynamic, kinetic, and structural study of reactions and of equilibrium in ceramic systems. Prerequisites: Chem. 451, 452. *Stubican*
- 505. PHASE TRANSITION IN SOLIDS (2) Phase transitions will be studied in detail with respect to the crystal structure, free energy, and physical properties. *McKinstry*
- 506. MECHANICAL PROPERTIES OF CERAMICS II (2) Theoretical considerations of dislocation processes, diffusion phenomena, and microstructural effects on the deformation and creep of ceramic materials. Prerequisite: Cer.S.E. 502. *Bradt*



507. **THERMAL PROPERTIES OF CERAMIC MATERIALS (2-3)** Heat capacity, heat of fusion, thermal conductivity, and thermal expansion in relation to macroscopic measurements and basic atomic concepts applied to ceramic materials. *Tressler*

508. **DIELECTRIC AND MAGNETIC PROPERTIES OF CERAMIC MATERIALS (2-3)** Preparation and properties of ceramic semiconductors, dielectrics, and magnetic materials. *Newnham*

509. **COMPOSITE MATERIALS (3)** Manufacturing processes, atomic and molecular background, and topological relationships of macro- and microstructure to the physical properties of composites. *Tressler*

510. **SEMINAR IN GLASS TECHNOLOGY (1-2 per semester)** Current developments in glass technology and related fields. *Pantano*

511. **THE CONSTITUTION OF GLASS (2-3 per semester)** Historical and current concepts of the atomic structure of glass; relationship of structure to chemical and physical properties. *Pantano*

596. **INDIVIDUAL STUDIES (1-9)**

602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)**

*NOTE: Courses in the use of X-ray diffraction, electron microscopy, and the electron microprobe in ceramic science studies are listed under Materials Science — as are introductory courses in thermodynamics, kinetics, crystal chemistry, and crystal physics.*

## CHEMICAL ENGINEERING (CH E)

LEE C. EAGLETON, *Head of the Department*  
160 Merrell R. Fenske Laboratory  
814-865-2574

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Paul Barton, Ph.D. (Penn State) *Assistant Professor of Chemical Engineering*  
Ronald P. Danner, Ph.D. (Lehigh) *Professor of Chemical Engineering*  
Thomas E. Daubert, Ph.D. (Penn State) *Professor of Chemical Engineering*  
J. Larry Duda, Ph.D. (Delaware) *Professor of Chemical Engineering*  
Lee C. Eagleton, D.Eng. (Yale) *Professor of Chemical Engineering*  
Alfred J. Engel, Ph.D. (Wisconsin) *Professor of Chemical Engineering*  
Friedrich G. Helfferich, Dr.rer.nat. (Göttingen, Germany) *Professor of Chemical Engineering*  
Robert L. Kabel, Ph.D. (Washington) *Professor of Chemical Engineering*  
John M. Tarbell, Ph.D. (Delaware) *Professor of Chemical Engineering*  
James S. Ultman, Ph.D. (Delaware) *Professor of Chemical Engineering*  
M. Albert Vannice, Ph.D. (Stanford) *Professor of Chemical Engineering*  
James S. Vrentas, Ph.D. (Delaware) *Professor of Chemical Engineering*

### Associate Members of the Graduate Faculty

Alfred Carlson, Ph.D. (Wisconsin) *Assistant Professor of Chemical Engineering*  
E. Earl Graham, Ph.D. (Northwestern) *Associate Professor of Chemical Engineering*  
Ramanathan Nagarajan, Ph.D. (S.U.N.Y., Buffalo) *Assistant Professor of Chemical Engineering*  
Charles C. Peiffer, Ph.D. (Penn State) *Associate Professor of Chemical Engineering*  
Jonathan Phillips, Ph.D. (Wisconsin) *Assistant Professor of Chemical Engineering*  
Daniel White, Jr., Ph.D. (Florida) *Assistant Professor of Chemical Engineering*

Course offerings or research facilities are available in the following areas: phase equilibria, thermodynamics, kinetics, catalysis, transport phenomena, unit operations and processes, optimization, polymer physics, bioengineering, process dynamics, mathematical modeling, applied chemistry, surface and colloid chemistry, petroleum technology, rheology, and lubrication.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are*

*in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

To be admitted, a student should be a graduate of an accredited major in chemical engineering or the equivalent. Graduates of other accredited engineering or physical science majors may be admitted but will be required to make up certain undergraduate deficiencies without graduate credit. Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

### **Master's Degree Requirements**

A minimum of 30 graduate credits is required and must include at least 18 credits in the 500 and 600 series combined. A thesis is required. There is no communication or language requirement.

### **Doctoral Degree Requirements**

A minimum of 30 graduate course credits is required and must include a minimum of 12 credits of 500-series Chemical Engineering courses taken at the University. Also included in these 30 credits is a minimum of 12 credits of non-Chemical Engineering courses in the 400 and 500 series in related fields. There is no communication or language requirement. The comprehensive examination consists of a written research proposal or project defended orally after it has been accepted.

### **Other Relevant Information**

The department wishes to have its graduate students begin their thesis research as soon as possible. Consequently, all new graduate students are matched to available research projects as soon as possible, usually within a month, after they join the department.

### **Student Aids**

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

CONTINENTAL OIL COMPANY FELLOWSHIP — Available to a graduate student in chemical engineering; stipend variable.

W. S. ELLIOTT FELLOWSHIP — Available to a graduate student who is a graduate of The Pennsylvania State University and is interested in engineering research; stipend variable. Apply to Office of the Dean, College of Engineering, 101 Hammond Building.

MARLIN G. GREIGER SCHOLARSHIP — Available to a first- or second-year student in Chemical Engineering who has a record of high scholarship and character, and who shows financial need; selected by faculty; stipend varies. This award is shared with the graduate program in Chemistry.

TAU BETA PI FELLOWSHIP — Open to any member of Tau Beta Pi, the engineering honor society, for a year of advanced study. Up to eighteen awards of \$3,500 each are available. Applications and information may be obtained from the Office of the Dean, College of Engineering, 101 Hammond Building. Application deadline is February 15.

## **CHEMICAL ENGINEERING (CH E)**

- 401. CHEMICAL PROCESS ENGINEERING (3)
- 407. CHEMICAL ENGINEERING LABORATORY (3)
- 408. CHEMICAL ENGINEERING LABORATORY II (2)
- 413. MASS TRANSFER OPERATIONS (4)
- 414. KINETICS AND INDUSTRIAL CHEMISTRY (4)
- 415. MATHEMATICAL MODELING IN CHEMICAL ENGINEERING (3)
- 416. TECHNIQUES OF PROCESS DESIGN (3)
- 420. CRYOGENIC ENGINEERING (3)
- 422. MODERN PETROLEUM TECHNOLOGY — PROCESSES AND PRODUCTS (3)
- 430. NUCLEAR CHEMICAL ENGINEERING (3)
- 431. ADVANCED INDUSTRIAL CHEMISTRY APPLICATIONS (3)
- 441. POLYMER PROCESSING (3)
- 446. INTRODUCTION TO TRANSPORT PHENOMENA (3)
- 448. ADVANCED MASS TRANSFER OPERATIONS (3)
- 450. PROCESS DYNAMICS (3)



453. THERMODYNAMICS FOR CHEMICAL ENGINEERS (3)  
 455. CHEMICAL REACTOR DESIGN (3)  
 460. CHEMICAL ENGINEERING (4)  
 464. DESIGN OF CHEMICAL PLANTS (3)  
 465. DESIGN PROJECTS IN CHEMICAL ENGINEERING (1-6)  
 494. RESEARCH PROJECTS IN CHEMICAL ENGINEERING (1-6)  
 497. SPECIAL TOPICS (1-9)
507. SIMULATION AND MODELING (3) Synthesis of subsystem and system models, emphasizing the generality of the principles for application to diverse physical and chemical processes.
509. HEAT TRANSFER APPLICATIONS (3) Advanced treatment of steady-state and transient conduction, convection, and radiation, with emphasis on numerical methods and design techniques. Prerequisite: an undergraduate course in heat transfer. *Daubert*
516. METHODS OF PROCESS DESIGN (3) Survey of mathematical techniques of chemical process design, with emphasis on economic choice and optimal decision making. *Engel*
524. CHEMICAL ENGINEERING, APPLICATION OF THERMODYNAMICS (3) Elements of thermochemistry and thermodynamics of greatest importance in chemical engineering.
535. CHEMICAL REACTION ENGINEERING (3) Optimal design of batch and continuous chemical reactors and reactor batteries; effect of mixing on reactor operation.
536. HETEROGENEOUS CATALYSIS (3) Thermodynamics and kinetics of adsorption and reactions on solid surfaces, heat and mass transfer effects, theory and correlations in catalysis. Prerequisites: Chem. 451, 452. *Vannice*
544. GENERAL TRANSPORT PHENOMENA (3) Formulation and solution of transport problems involving momentum, heat, and mass transfer, with chemical engineering applications. Prerequisites: Ch.E. 302, 413.
545. TRANSPORT PHENOMENA I (3) Momentum transport, laminar and turbulent flow, boundary layer analysis, non-Newtonian flow, mechanical energy balance, chemical engineering applications.
546. TRANSPORT PHENOMENA II (3) Heat and mass transfer, steady and unsteady state, coupling, molecular diffusion, moving boundaries, transfer coefficients, chemical engineering applications.
548. MULTISTAGE MASS TRANSFER OPERATIONS (3) Rigorous solution of complex problems in distillation, extraction, and absorption, including computer methods. Prerequisite: an undergraduate course in mass transfer. *Barton*
550. DYNAMICS OF CHEMICAL SYSTEMS (3) Systems models; steady-state multiplicity; linear and nonlinear stability; oscillatory and chaotic states; multivariable and optimal; nonequilibrium thermodynamic stability. Prerequisite: Ch.E. 450. *Tarbell*
596. INDIVIDUAL STUDIES (1-9)  
 597. SPECIAL TOPICS (1-9)  
 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## CHEMISTRY (CHEM)

JOSEPH A. DIXON, *Head of the Department*  
 152 Davey Laboratory  
 814-865-6553

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Harry R. Allcock, Ph.D. (London) *Professor of Chemistry*  
 James B. Anderson, Ph.D. (Princeton) *Professor of Chemistry*  
 Stephen J. Benkovic, Ph.D. (Cornell) *Professor of Chemistry*  
 Robert A. Bernheim, Ph.D. (Illinois) *Professor of Chemistry*  
 A. W. Castleman, Ph.D. (Polytechnic Institute of Brooklyn) *Professor of Chemistry*  
 Joseph A. Dixon, Ph.D. (Penn State) *Professor of Chemistry*

## CHEMISTRY

James J. Fritz, Ph.D. (California) *Professor of Chemistry*  
Gregory L. Geoffroy, Ph.D. (California Tech.) *Associate Professor of Chemistry*  
L. Peter Gold, Ph.D. (Harvard) *Associate Professor of Chemistry*  
Charles G. Haas, Jr., Ph.D. (Chicago) *Professor of Chemistry*  
Gordon A. Hamilton, Ph.D. (Harvard) *Professor of Chemistry*  
Julian P. Heicklen, Ph.D. (Rochester) *Professor of Chemistry*  
I. Clarence Hisatsune, Ph.D. (Washington) *Professor of Chemistry*  
William DeW. Horrocks, Jr., Ph.D. (M.I.T.) *Professor of Chemistry*  
Lloyd M. Jackman, Ph.D. (Adelaide) *Professor of Chemistry*  
Joseph Jordan, Ph.D. (Hebrew University) *Professor of Chemistry*  
Peter C. Jurs, Ph.D. (Washington) *Professor of Chemistry*  
Frederick W. Lampe, Ph.D. (Columbia) *Professor of Chemistry*  
John P. Lowe, Ph.D. (Northwestern) *Associate Professor of Chemistry*  
C. Robert Matthews, Ph.D. (Stanford) *Associate Professor of Chemistry*  
Roy A. Olofson, Ph.D. (Harvard) *Professor of Chemistry*  
Herman G. Richey, Jr., Ph.D. (Harvard) *Professor of Chemistry*  
Maurice Shamma, Ph.D. (Wisconsin) *Professor of Chemistry*  
Philip S. Skell, Ph.D. (Duke) *Professor of Chemistry*  
William A. Steele, Ph.D. (Washington) *Professor of Chemistry*  
Joseph J. Villafranca, Ph.D. (Purdue) *Professor of Chemistry*  
Thomas Wartik, Ph.D. (Chicago) *Professor of Chemistry*  
Steven M. Weinreb, Ph.D. (Rochester) *Professor of Chemistry*  
Nicholas Winograd, Ph.D. (Case Western Reserve) *Professor of Chemistry*

### **Associate Members of the Graduate Faculty**

Philip R. DeShong, Ph.D. (M.I.T.) *Assistant Professor of Chemistry*  
Barbara J. Garrison, Ph.D. (California, Berkeley) *Associate Professor of Chemistry*  
Robert D. Minard, Ph.D. (Cornell) *Lecturer*  
Ayusman Sen, Ph.D. (Chicago) *Assistant Professor of Chemistry*

The Ph.D. program in Chemistry provides students with a broad background in one of the major areas of chemistry (analytical, biological, inorganic, organic, or physical) and intensive research experience culminating in the preparation of a formal thesis. The goal of the program is to prepare students for a variety of careers in academia, government, or industry. The exceptionally high quality of our laboratory and computer facilities enables us to provide students with outstanding research opportunities. Distinguished visiting scholars conduct informal discussions each Thursday at a departmental colloquium.

### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in the program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

For admission, at least integral calculus plus one year's work in general physics, organic chemistry, physical chemistry, and either analytical or inorganic chemistry are normally required. Students who have appropriate course backgrounds and who present a 2.50 average in all undergraduate courses in chemistry, physics, and mathematics will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

### **Master's Degree Requirements**

The program of the M.S. candidate must include a total of at least 30 graduate-level course credits (Chem. 451, 452, 489, and 500 may not be included in this credit count.) These 30 credits must be apportioned so that at least 18 credits are in the Chemistry 400 and 500 series. (Chem. 589 credits may not be included in these 18 credits.)

Additional requirements of the M.S. program are that the candidate must write either a thesis or research report and must defend this thesis or report at an oral examination. The thesis or report will be accomplished under the sponsorship of a faculty member, and the candidate must schedule at least 6 credits of Chem. 600 (for a thesis) or Chem. 589 (for a research report) to fulfill this requirement. The candidate's attainments under a thesis or research report must be approved by a committee of at



least three faculty members, one of whom will be the candidate's sponsor.

A knowledge of French, German, Japanese, or Russian equivalent to that gained by taking and passing two undergraduate courses in one of these languages is required.

Qualifying examinations in analytical, inorganic, organic, and physical chemistry will be given to all new students upon entrance in the fall semester. These cover subject matter at the level of the basic courses offered for the B.S. degree in chemistry at Penn State. For certification as an M.S. candidate, proficiency in two areas is required. These must include physical chemistry and the student's area of concentration. Such proficiency may be demonstrated either by (1) passing the area examination upon entrance, or (2) obtaining a grade of A or B in at least 3 credits of graduate-level course work in the area. The courses to be used to fulfill this latter option will be designated by the graduate counseling committee. This course work must be completed successfully during the student's first two semesters.

A final oral examination will be administered by a committee consisting of the student's research preceptor and two other faculty members. This examination is scheduled after the M.S. thesis or research report has been completed.

### Doctoral Degree Requirements

Candidates for the Ph.D. degree in Chemistry must meet the following requirements established by the department faculty.

A knowledge of French, German, Japanese, or Russian equivalent to that gained by taking and passing two undergraduate courses in one of these languages is required.

A Ph.D. candidate shall be required to take a minimum of five 2- or 3-credit courses in Chemistry at the 400-500 level (excluding Chem. 451 and 452). Individual areas of concentration may specify one or more specific courses within this minimum requirement. The candidate's doctoral committee may require additional specific courses.

Qualifying examinations in analytical, inorganic, organic, and physical chemistry will be given to all new students upon entrance in the fall semester. These cover subject matter at the level of the basic courses offered for the B.S. degree in chemistry at Penn State. As a part of the requirements for certification as a Ph.D. candidate, each student will be expected to demonstrate proficiency in three areas of chemistry, including physical chemistry and the student's area of concentration. Such proficiency may be demonstrated either by (a) passing the area examination upon entrance, or (b) obtaining a grade of A or B in at least 3 credits of graduate-level course work in the area. The courses to be used to fulfill this latter option will be designated by the graduate counseling committee. This course work must be completed successfully during the student's first two semesters.

In order to qualify for the oral comprehensive examination, a Ph.D. candidate shall pass six cumulative examinations, two of which may be outside his or her area of specialization, during the first two years of residency. Cumulative examinations will be given monthly.

A Ph.D. candidate shall take the oral comprehensive examination during his or her first two and one-half years of residency.

Every Ph.D. candidate shall present at least one area or department seminar during the course of residency.

A final oral examination based on a defense of the doctoral thesis is required of all candidates.

### Other Relevant Information

All candidates for advanced degrees must schedule Chem. 602, Supervised Experience in College Teaching, for 1 credit for each of two semesters. This requirement may be waived or modified for students who have attained satisfactory competence in teaching as a result of prior experience.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin. It is important to note that department policy limits financial support from *department funds* to the *first two years* of graduate study of an M.S. candidate and to the *first five years* of graduate study of a Ph.D. candidate. Financial support beyond these periods is permitted from other than department funds, e.g., a research assistantship funded from an individual faculty member's research grant(s).

### CHEMISTRY (CHEM)

- 400. CHEMICAL LITERATURE (1)
- 405. (Nuc.E. 405) APPLIED NUCLEAR AND RADIOCHEMISTRY (3)
- 408. (Cmp.Sc. 408) COMPUTER APPLICATIONS IN CHEMISTRY (3)

## CHEMISTRY

- 410. INORGANIC CHEMISTRY (3)
- 411. ADVANCED INORGANIC CHEMISTRY (3)
- 427. INSTRUMENTAL ANALYSIS (2)
- 428. INSTRUMENTAL ANALYSIS (2)
- 429. INSTRUMENTAL ANALYSIS (2)
- 431. ORGANIC AND INORGANIC PREPARATIONS (3)
- 439. STRUCTURAL ANALYSIS OF ORGANIC COMPOUNDS (3)
- 448. SURFACE CHEMISTRY (2)
- \*451-452. PHYSICAL CHEMISTRY (3 each)
- 453. THERMODYNAMICS OF CHEMICAL SYSTEMS (3)
- 454. INTRODUCTION TO QUANTUM CHEMISTRY (3)
- 455. PHYSICAL CHEMISTRY OF HIGH POLYMERS (3)
- \*457. EXPERIMENTAL PHYSICAL CHEMISTRY (1-2)
- \*458. EXPERIMENTAL PHYSICAL CHEMISTRY (1-2)
- †489. INTRODUCTION TO CHEMICAL RESEARCH (1-10 per semester, maximum of 20)
- 497. SPECIAL TOPICS (1-9)
  
- 500. SEMINAR IN CHEMISTRY (1 per semester)
  
- 516-517. INORGANIC CHEMISTRY (3 each) Systematic treatment of inorganic chemistry in terms of modern concepts.
- 518. SPECIAL TOPICS IN INORGANIC CHEMISTRY (3 per semester) Modern developments in specialized fields.
- 525. ANALYTICAL PROCESSES (3) Theoretical foundations and contemporary developments.
- 526. MODERN INSTRUMENTAL ANALYSIS (3)
- 527. SPECIAL TOPICS IN ANALYTICAL CHEMISTRY (2-12)
- 531. SPECIAL TOPICS IN ORGANIC CHEMISTRY (3-12) Prerequisite: Chem. 536.
- 534. CHEMICAL APPLICATIONS OF QUANTUM THEORY (3) A development of Molecular Orbital Theory up to the level of present-day usage in organic and inorganic chemistry.
- 535-536. ORGANIC REACTION MECHANISMS I AND II (3 each) Reaction mechanisms and their determination by kinetic and nonkinetic methods: Reactive intermediates. Prerequisite: Chem. 439.
- 537. SYNTHESIS IN ORGANIC CHEMISTRY (3) Theory and methods of directed syntheses, including stereospecific and stereoselective schemes; biologically inspired syntheses. Prerequisite: Chem. 536.
- 544. CHEMICAL THERMODYNAMICS (3) Development of thermodynamic theory, with special reference to common physical changes and chemical reactions. Prerequisite: Chem. 452.
- 545. STATISTICAL THERMODYNAMICS (3) The calculation of thermodynamic properties from molecular and spectroscopic data. Prerequisites: Chem. 453 or 544; Chem. 565.
- 560. TOPICS IN PHYSICAL CHEMISTRY (2-6)
- 563. CHEMICAL KINETICS (3) Theory and measurement of the rates of chemical reactions, molecular dynamics, and mechanisms of chemical reactions. Prerequisites: Chem. 453 or 544; Chem. 565.
- 565. ATOMIC AND MOLECULAR STRUCTURE (3) Introduction to modern theoretical chemistry, spectroscopy, and structure of atoms and molecules.
- 566. QUANTUM CHEMISTRY (3) Theoretical calculations of electronic properties of atoms and molecules. Prerequisite: Chem. 565.
- 567. QUANTUM CHEMISTRY (3) A continuation of Chem. 566, including problems and theories of electron correlation. Prerequisite: Chem. 566.
- 571. POLYMER CHEMISTRY (3) The synthesis, reactions, and structure determination of high polymers.

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\*Graduate credit not allowed for students majoring in Chemistry or Chemical Engineering.

†Graduate credit not allowed for students majoring in Chemistry.



589. **STUDIES IN CHEMISTRY (1-9)** Theoretical research, experimental research, or a critical survey of the literature in an area of chemistry.
602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)**

## CIVIL ENGINEERING (C E)

ROBERT M. BARNOFF, *Head of the Department*  
212 Sackett Building  
814-865-8391

**Degrees Conferred:** Ph.D., M.S., M.Eng.

### Senior Members of the Graduate Faculty

David A. Anderson, Ph.D. (Purdue), P.E. *Professor of Civil Engineering*  
Gert Aron, Ph.D. (California), P.E. *Professor of Civil Engineering*  
Robert M. Barnoff, Ph.D. (Carnegie Tech.), P.E., P.L.S. *Professor of Civil Engineering*  
Philip D. Cady, Ph.D. (Penn State), P.E., P.L.S. *Professor of Civil Engineering*  
William H. Gotolski, Ph.D. (Penn State), P.E. *Professor of Civil Engineering*  
David F. Kibler, Ph.D. (Colorado State), P.E. *Professor of Civil Engineering*  
Thomas D. Larson, Ph.D. (Penn State), P.E. *Professor of Civil Engineering*  
David A. Long, Ph.D. (Penn State), P.E. *Associate Professor of Civil Engineering*  
Archibald J. McDonnell, Ph.D. (Penn State) *Professor of Civil Engineering*  
Arthur G. Miller, Ph.D. (Colorado State), P.E. *Associate Professor of Civil Engineering*  
John B. Nesbitt, Sc.D. (M.I.T.) *Professor of Civil Engineering*  
Joseph R. Reed, Ph.D. (Cornell), P.E. *Associate Professor of Civil Engineering*  
Raymond W. Regan, Ph.D. (Kansas), P.E. *Associate Professor of Civil Engineering*  
H. Randolph Thomas, Ph.D. (Vanderbilt), P.E. *Associate Professor of Civil Engineering*  
Raymond E. Untrauer, Ph.D. (Illinois), P.E. *Professor of Civil Engineering*  
Richard F. Unz, Ph.D. (Rutgers) *Professor of Environmental Microbiology*  
Mian C. Wang, Ph.D. (California), P.E. *Associate Professor of Civil Engineering*  
Harry H. West, Ph.D. (Illinois), P.E. *Associate Professor of Civil Engineering*  
Jack H. Willenbrock, Ph.D. (Penn State), P.E. *Professor of Civil Engineering*

### Associate Members of the Graduate Faculty

Thomas B. Davinroy, D.Eng. (California) *Associate Professor of Civil Engineering*  
Steven Deutsch, Ph.D. (Penn State) *Research Associate at the Applied Research Laboratory*  
William J. Gburek, Ph.D. (Penn State) *Adjunct Assistant Professor of Civil Engineering*  
Walter P. Kilareski, Ph.D. (Penn State), P.E., P.L.S. *Assistant Professor of Civil Engineering*  
G. Warren Marks, Ph.D. (Illinois), P.L.S. *Associate Professor of Civil Engineering*  
Richard M. McClure, Ph.D. (Penn State), P.E. *Associate Professor of Civil Engineering*  
Ralph R. Mazingo, M.S. (Penn State) *Associate Professor of Civil Engineering*

Students may specialize in structures, hydraulics, hydrology, transportation engineering, traffic engineering, materials, construction, soils, and environmental engineering, or combinations of these. Relevant courses are offered both by the Department of Civil Engineering and by other departments of the University.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Candidates normally should be graduates from an accredited program in engineering. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

### Degree Requirements

A thesis is required for the M.S. degree. An engineering report is required for the M.Eng. degree. In addition to demonstrating competence in English, each candidate for the Ph.D. degree must meet a foreign language or communication skills requirement established by the department.

### Other Relevant Information

Students in this program may elect the dual-title degree program option in Operations Research for the Ph.D. and M.S. degrees (see p. 285).

*See also Environmental Engineering.*

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

**ARTHUR ANDERSON & CO. CONSTRUCTION MANAGEMENT FELLOWSHIP** — Available to a graduate student in civil engineering to support the study phase of his or her graduate work study program in construction management; stipend \$6,000.

**BECHTEL POWER CORPORATION POWER PLANT CONSTRUCTION MANAGEMENT FELLOWSHIP** — Available to a graduate student in civil engineering to support the study phase of his or her work study program in power plant construction management; stipend \$2,400.

**W. S. ELLIOTT FELLOWSHIP** — Available to a graduate student who is a graduate of The Pennsylvania State University and is interested in engineering research; stipend variable. Apply to Office of the Dean, College of Engineering, 101 Hammond Building.

**P.P.&L. POWER PLANT CONSTRUCTION MANAGEMENT GRANT** — Available to a graduate student in civil engineering to support a portion of the study phase of his or her graduate work study program with P.P.&L.; stipend \$2,976.

**FRED B. ROONEY TRANSPORTATION SCHOLARSHIP** — Established by the Seley Foundation and available to a graduate student in civil engineering who is a permanent resident of either Lehigh or Northampton County, Pennsylvania, and who is specializing in transportation engineering. Apply to the Department of Civil Engineering, 212 Sackett Building.

**J. WALDO SMITH HYDRAULIC FELLOWSHIP** — Established by the American Society of Civil Engineers, Board of Direction, for a graduate student who is preferably an associate member of ASCE. Awarded every third year; \$2,000 for one full academic year, plus a maximum of \$1,000 for research equipment, preferably in the field of experimental hydraulics. More information can be obtained from the Department of Civil Engineering, 212 Sackett Building.

**STONE & WEBSTER ENGINEERING CORP. FELLOWSHIP** — Available to a graduate student in civil engineering to support the study phase of a work study program in power plant construction management; stipend \$6,240 for four terms.

**TAU BETA FELLOWSHIP** — Open to any member of Tau Beta Pi, the engineering honor society, for a year of advanced study. Up to eighteen awards of \$3,500 each are available. Application and information may be obtained from the Office of the Dean, College of Engineering, 101 Hammond Building. Application deadline is February 15.

**HARRY F. THOMSON SCHOLARSHIP** — Established by the American Concrete Institute for graduate study in the field of concrete. The scholarship is open to any student who is completing studies toward the bachelor's degree or who has received a bachelor's degree from an accredited engineering program. The applicant must be accepted for graduate study of concrete, involving design, materials, construction, or any combination of these subject areas, at a recognized university or college at the time of the award. Information and applications may be obtained from the Department of Civil Engineering, 212 Sackett Building. Application deadline is February 1.

### CIVIL ENGINEERING (C E)

- 400. SEMINAR (1-3)
- 411. BOUNDARY SURVEYING (3)
- 412. PHOTOGRAMMETRY AND PHOTO INTERPRETATION (3)
- 421. TRANSPORTATION FACILITIES DESIGN (3)
- 423. TRANSPORTATION SYSTEMS OPERATIONS (3)



- 424. CIVIL ENGINEERING MATERIALS (3)
  - 427. RAILWAY TRACK STRUCTURE AND TERMINAL SYSTEMS (3)
  - 428. RAILWAY OPERATING SYSTEMS AND ANALYSIS (3)
  - 431. CIVIL ENGINEERING CONSTRUCTION (3)
  - 432. CONSTRUCTION PROJECT CONTROL (3)
  - 446. ADVANCED SOIL MECHANICS I (3)
  - 447. STRUCTURAL ANALYSIS BY MATRIX METHODS (3)
  - 448. ADVANCED STRUCTURAL DESIGN (3)
  - 449. DESIGN OF PRESTRESSED AND REINFORCED CONCRETE STRUCTURES (3)
  - 451. ADVANCED HYDROLOGY (3)
  - 462. OPEN CHANNEL HYDRAULICS (3)
  - 465. RIVER AND WATERWAYS ENGINEERING (3)
  - 471. ENVIRONMENTAL SANITATION (3)
  - 472. WATER POLLUTION CONTROL PROCESSES (3)
  - 473. WATER QUALITY MANAGEMENT (3)
  - 474. MANAGEMENT OF WATER POLLUTION CONTROL PROCESSES (3)
  - 475. WATER QUALITY CHEMISTRY (1)
  - 476. SOLID WASTE MANAGEMENT (3)
  - 496. INDEPENDENT STUDIES (1-18)
  - 497. SPECIAL TOPICS (1-9)
511. ENGINEERING SOIL CHARACTERISTICS (3) Applications of physico-chemical principles in soil engineering, soil composition, factors influencing engineering soil properties. Prerequisite: C.E. 244.
512. SOIL MECHANICS II (2-5) Evaluation of strength parameters and compressibility of soils; elastic analysis of stress and strain; techniques of forecasting foundation settlement; slope stability analysis. Prerequisite: C.E. 446.
513. ADVANCED FOUNDATION ENGINEERING (3) Practical applications of soil mechanics principles to geotechnical engineering problems; dewatering techniques; design of deep foundations and retaining structures. Prerequisite: C.E. 244.
518. LAND USE MODELS (3) The urban planning process; transportation models; economic, residential, industrial retail, and public sector submodels; integrated models; simulation models; evaluative models. Prerequisite: 3 credits of computer science.
520. PAVEMENT DESIGN (3) Fundamental principles; properties of pavement components; design tests; design of flexible pavements; design of rigid pavements; pavement evaluation and strengthening. Prerequisites: C.E. 224, 244.
521. TECHNIQUES OF TRANSPORTATION ANALYSIS (2-4) Transportation functions, travel patterns, basic analytical methods in the planning content. Prerequisite: 3 credits of computer science.
522. HIGHWAY OPERATIONS (2) Theory and application of traffic controls, including functional operations of traffic signals, systems, and networks; the design of highway lighting. Prerequisite: C.E. 423.
523. URBAN TRANSPORTATION PLANNING, TECHNOLOGY, POLICY, AND ADMINISTRATION (2-4) Characteristics of urban areas, the urban transportation planning process, present and future urban transportation systems, urban transportation policy and administration. Prerequisite: C.E. 221.
524. ADVANCED PROBLEMS IN CIVIL ENGINEERING MATERIALS (2-6) Study in the literature and by laboratory investigation of selected topics on field-controlled civil engineering materials. Prerequisite: C.E. 424.
525. AIRPORT PLANNING AND DESIGN (3) Aircraft characteristics; aeronautical demand; site selection; airport configuration; capacity analysis; design of landing and terminal areas. Prerequisite: C.E. 221.
531. LEGAL ASPECTS OF ENGINEERING AND CONSTRUCTION (3) Basic legal doctrines, contractual relationships between parties, analysis of construction contract clauses, contract performance, and professional practice problems. Prerequisite: C.E. 431.
532. POWER PLANT CONSTRUCTION (3) Fossil and nuclear power generation; analysis of power plant design and civil, mechanical, and electrical construction phases; quality assurance role. Prerequisite: C.E. 431.

539. APPROXIMATE METHODS OF STRUCTURAL ANALYSIS (3) Structural analysis through the application of initial-value methods, Newark's method, Fourier series, finite difference techniques, and work and energy procedures. Prerequisite: C.E. 240.
540. STRUCTURAL ANALYSIS BY CLASSICAL METHODS (3) Analysis of continuous trusses and beams, frames, arches, grids, curved beams, suspension systems, and space frames. Prerequisite: C.E. 240.
541. STRUCTURAL ANALYSIS (3) Theory of various finite elements as applied to civil engineering structures. Term paper required. Prerequisite: C.E. 447.
544. REINFORCED CONCRETE STRUCTURES (3) Working stress, ultimate strength, and limit design; test behavior of beams, columns, and slabs. Prerequisite: C.E. 341.
545. DESIGN OF METAL STRUCTURES (3) Steel, aluminum members; flexible connections; composite, hybrid, prestressed beams; tension-field beams; buckling; plastic analysis, design; test data; timber design. Prerequisite: C.E. 342.
546. THIN CONCRETE STRUCTURES (3) Design of thin concrete structures, including slabs, folded plates, and shells. Prerequisite: C.E. 341.
548. STRUCTURAL DESIGN FOR DYNAMIC LOADS (3) Dynamic behavior of structural systems of one and more degrees of freedom; earthquake, blast-resistant analysis, and design of structures. Prerequisites: E.Mch. 12, C.E. 240.
550. ENGINEERING CONSTRUCTION MANAGEMENT (3) Management fundamentals for construction contracting; organization, project planning, scheduling and control, bonding and insurance, labor legislation and regulation, cost and control. Prerequisite: C.E. 431.
551. HYDROLOGIC INVESTIGATIONS (2-8) Application of hydrologic principles and techniques to a specific project. Prerequisite: C.E. 451.
552. HYDROLOGIC PROCESSES AND CYBERNETICS (3) Application of cybernetic concepts in electronic computer simulation of the hydrologic process-components: infiltration, precipitation, evapotranspiration, and overland flow. Prerequisite: C.E. 351.
553. PLANNING MULTIPURPOSE HYDROLOGIC SYSTEMS (3) Study of multipurpose hydrologic schemes within a social, economic, and political framework. Prerequisites: C.E. 451, Econ. 14.
554. URBAN HYDROLOGY (3) Several hydrograph methods. Design storm and IUH application; airport drainage; flood plains; impact of urbanization upon groundwater and sediment. Prerequisite: C.E. 451.
560. DIMENSIONAL ANALYSIS AND THEORY OF MODELS (3) Principles of dimensional analysis and similitude, with engineering applications primarily to problems in hydromechanics. Prerequisite: C.E. 261.
564. HYDRAULIC ENGINEERING DESIGN (3) Design and analysis of selected units of a typical hydraulic engineering project. Prerequisite: C.E. 362.
570. PHYSICAL CHEMICAL TREATMENT PROCESSES I (2) The theory of physical-chemical processes used in the treatment of potable water and municipal and industrial wastewaters. Prerequisite: C.E. 472.
571. PHYSICAL CHEMICAL TREATMENT PROCESSES II (3) The theory of physical-chemical processes used in the treatment of potable water and municipal and industrial wastewaters. Prerequisite: C.E. 472.
572. BIOLOGICAL TREATMENT PROCESSES (2) The theory of biological processes used in the treatment of municipal and industrial wastewaters. Prerequisite: C.E. 472.
574. LABORATORY ANALYSES IN WATER QUALITY CONTROL (3) Experiments illustrating current chemical and biochemical methods of water and waste treatment and analytical methods used in research and control. Prerequisite: C.E. 475.
575. INDUSTRIAL WASTE TREATMENT (2) Surveys and data analysis; use of unit processes to meet regulatory agency requirements; disposal of gaseous and solid residues. Prerequisite: C.E. 472.
577. TREATMENT PLANT DESIGN (1-6) Design of works for the treatment of water and wastewater for municipalities and industries. Prerequisites: C.E. 472; 3 credits in hydraulics.



579. (Micrb. 529) **AQUATIC MICROBIOLOGY (3)** Ecology and physiology of microorganisms of inland waters, estuaries, and oceans; microbiology of wastewater treatment. Prerequisite: introductory microbiology.
580. **STREAM AND ESTUARINE ANALYSIS (3)** Quantitative assessment of advection, reaction, and dispersion processes in polluted waters; reaeration theory; eutrophic systems; analog simulation. Prerequisite: C.E. 472.
590. **COLLOQUIUM (1-3)**
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**
602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)**

## COMMUNICATION DISORDERS (CMDIS)

BRUCE M. SIEGENTHALER, *In Charge of Graduate Programs in Communication Disorders*  
125 Moore Building  
814-863-2009

**Degrees Conferred:** Ph.D., M.S., M.Ed.

### Senior Members of the Graduate Faculty

Thomas A. Frank, Ph.D. (Wisconsin) *Associate Professor of Audiology*  
James V. Frick, Ph.D. (Iowa) *Associate Professor of Speech Pathology*  
Harvey R. Gilbert, Ph.D. (Wisconsin) *Associate Professor of Speech Communication and Speech Science*  
Paul L. Michael, Ph.D. (Pittsburgh) *Professor of Environmental Acoustics*  
Bruce M. Siegenthaler, Ph.D. (Michigan) *Research Professor of Speech Pathology and Audiology*  
Frederick F. Weiner, Ph.D. (Wayne State) *Associate Professor of Communication Disorders*

### Associate Members of the Graduate Faculty

Asa J. Berlin, Ph.D. (Northwestern) *Professor of Speech Pathology*  
Gordon R. Bienvenue, Ph.D. (Penn State) *Research Associate in Communication Disorders*  
Stephen N. Calculator, Ph.D. (Wisconsin) *Assistant Professor of Communication Disorders*  
Neita Israelite, Ph.D. (Pittsburgh) *Assistant Professor of Special Education*  
Philip M. Prinz, D.Ed. (Boston) *Assistant Professor of Communication Disorders*  
Richard G. Stoker, Ph.D. (McGill) *Assistant Professor of Communication Disorders*

The general goal of the program is to prepare competent professionals to habilitate and rehabilitate, either directly or indirectly, people who have speech, language, or hearing problems. Students may specialize in speech-language pathology, audiology, or hearing impairment.

Facilities for student training and research include in-house clinical therapy and diagnostic services, laboratories in speech science, audiology, and environmental acoustics, and affiliated schools and clinics. The program enjoys academic, research, and clinical relationships with a number of related programs at Penn State and draws upon academic work from related areas as part of the graduate training in communication disorders. Preparation is given for school and professional certifications. The program is approved by the Conference of Educators of the Deaf (CED) and by the American Board of Examiners in Speech Pathology and Audiology (ABESPA) for speech and audiology for both academic training and clinical services. Graduate study requires some field trips and usually a full-time internship experience, ordinarily at an external site.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Approximately 36 credits are required for admission, distributed among speech pathology, audiology, education of the hearing impaired, speech science, education, and psychology, and including a

## COMMUNICATION DISORDERS

course in statistics. Students entering without an undergraduate program in the field may be required to take additional makeup work.

Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

Usually students earn a master's degree in communication disorders prior to being considered for doctoral study, although persons with master's degrees in other fields will be considered for a doctoral program that includes studying necessary background information.

### Master's Degree Requirements

The master's degrees require a minimum of 50 graduate credits beyond admission standards. Students usually earn 55 to 65 credits to complete a degree, over four semesters and a summer of study.

There is a nonthesis option for the Master of Science degree, requiring a paper and additional course credits in lieu of a thesis. M.Ed. students may submit a thesis instead of a master's paper. The master's program of study provides course work and practicum for advanced or professional-level certification.

### Doctoral Degree Requirements

The Doctor of Philosophy degree normally requires a master's degree in communication disorders or a related field, plus a minimum of two years of advanced study, and presentation and oral defense of a research-based dissertation.

The communication and foreign language requirement is a minimum of 6 credits of statistics beyond the first course, plus 9 credits selected from among statistics, technical writing, computer science, research design, or a foreign language.

Two research exercises, one of which is used for doctoral candidacy evaluation early in the doctoral program, are required prior to the dissertation. Comprehensive written examinations lasting about two and a half days in the areas of a student's interest and an optional minor field examination, plus a follow-up oral examination prior to dissertation, are required.

Details of a student's doctoral program are determined by the doctoral committee.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

U.S. OFFICE OF EDUCATION FELLOWSHIPS IN SPEECH PATHOLOGY AND AUDIOLOGY: WORK WITH THE SPEECH-HANDICAPPED; WORK WITH THE DEAF — Open to graduate students specializing in these fields; stipend up to \$1,200-2,400. Apply to the Communication Disorders Program.

U.S. REHABILITATION SERVICES ADMINISTRATION TRAINEESHIPS IN SPEECH PATHOLOGY AND AUDIOLOGY (7) — Open to graduate students specializing in speech pathology and audiology and hearing impaired; stipend up to \$2,400-4,100. Apply to the Communication Disorders Program.

## COMMUNICATION DISORDERS (CMDIS)

- 400. DEVELOPMENTAL CONSIDERATIONS IN THE ASSESSMENT AND TREATMENT OF LANGUAGE DISORDERS (3)
- 430. INTRODUCTION TO AUDIOLOGY (4)
- 433. AURAL REHABILITATION (3)
- 434. ELECTRONYSTAGMOGRAPHY (2)
- 440. (Spl.Ed. 440) SURVEY OF SPEECH AND HEARING DISORDERS (3)
- 442. SPEECH PATHOLOGY I (3)
- 444. SPEECH PATHOLOGY II (4)
- 445. PROFESSIONAL PROGRAMS AND RELATIONSHIPS (3)
- 459. PRINCIPLES OF CLINICAL MANAGEMENT IN COMMUNICATION DISORDERS (2)
- 460. THEORETICAL BASIS OF TEACHING SPEECH TO THE HEARING IMPAIRED (3)
- 462. CLINICAL BASES OF LANGUAGE DISORDERS (2)
- 463. TEACHING LANGUAGE TO THE HEARING IMPAIRED (3)
- 464-465. TEACHING SCHOOL SUBJECTS TO THE DEAF (2 each)
- 468. MANUAL COMMUNICATION II (2)
- 469. MANUAL COMMUNICATION III (2)
- 495A. SPEECH THERAPY PRACTICUM (1-6)



- 495B. HEARING IMPAIRMENT PRACTICUM (1-5)
- 495C. HEARING IMPAIRMENT INTERNSHIP (6-15)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

515. APPLICATION OF PHYSIOLOGICAL AND ACOUSTICAL CONCEPTS OF SPEECH PATHOLOGY AND AUDIOLOGY (4) Application of practical and theoretical concepts in neurology, physiology, and acoustics to communication disorders, with implications for clinical therapy. Prerequisites: 6 credits in speech science; 6 credits in speech pathology and audiology.

517. (Ling. 517) THEORETICAL BASES OF LANGUAGE DISORDERS IN CHILDREN AND ADULTS (3) Application of linguistic theory to the understanding of communication disorders, with clinical implications for speech and language therapy. Prerequisites: 12 credits in communication disorders or related fields, including a course in language acquisition.

522. (Sp.Com. 522) SPEECH PERCEPTION (3) Transformation of linguistic units into acoustic speech signals, theories of speech perception, and auditory processing of the speech signal. Prerequisites: Sp.Com. 410, 431, 520.

531. HEARING AIDS (3) Hearing aid circuitry, electroacoustic characteristic measurement, and evaluation techniques and procedures for infants, children, and adults. Prerequisites: Cm.Dis. 535, 567.

532. ACOUSTICAL INSTRUMENTS FOR HEARING (3) Acoustical instrumentation used for research in hearing, programs of hearing conservation, and noise control, including clinical and industrial applications. Prerequisites: 6 credits in acoustics, audiology, experimental psychology, or speech science at the 400 level.

533. SPEECH AUDIOMETRY (3) Techniques, interpretation, and differential diagnosis of hearing ability employing speech and speech-like materials in children and adults. Prerequisites: Acs. 401, Cm.Dis. 430, 433; 6 additional credits in communication disorders.

534. NOISE AND HEARING (3) Noise-induced hearing problems; interference with communication; annoyance and community problems caused by acoustic energy; regulations and standards. Prerequisites: 6 credits at the 400 level in acoustics, audiology, experimental psychology, or speech science.

535. PURE TONE AUDIOMETRY (4) Techniques, interpretation, and differential diagnosis of hearing ability by pure tone and related audiometric techniques. Prerequisites: Cm.Dis. 430, 433, Acs. 401; 6 credits in speech pathology and audiology.

540. ARTICULATION DISABILITIES (3) Speech-sound production disorders in children and adults; methods of examination, diagnosis, and treatment. Prerequisite: Cm.Dis. 442, 495A.

541. THE VOICE AND ITS DISORDERS (3) Physical, physiological, and psychological bases of voice production; causes, nature, and symptoms of its disorders; current clinical methods in voice improvement. Prerequisites: Cm.Dis. 444, 495A.

542. STUTTERING (3) Modern theories of causes of disorders of rhythm; methods of examination, diagnosis, and treatment. Prerequisites: Cm.Dis. 442, 495A.

543. DIAGNOSTIC PROCEDURES IN SPEECH PATHOLOGY (3) Clinical instrumentation; case history taking; examination procedures and materials used in diagnosing speech disabilities; interpretation of findings; report preparation. Prerequisites: 15 credits in communication disorders.

544. CLEFT PALATE (3) Anatomy, physiology, embryology, and growth of the palate and contiguous structures; etiology, diagnosis, habilitation of cleft palate problems. Prerequisite: Cm.Dis. 444.

545. NEUROMOTOR DISORDERS OF SPEECH (3) Etiology and symptomatology of dysarthric and apraxic speech; diagnosis, treatment, and the team rehabilitative program approach to these disorders. Prerequisite: Cm.Dis. 444 or 515 or Sp.Com. 431.

546. LANGUAGE DISORDERS IN ADULTS (3) Nature, etiology, diagnosis, and management of language disorders in adults. Prerequisites: 9 credits in speech pathology and audiology or related fields such as psychology, linguistics, or human development.

547. (Spl.Ed. 547) LANGUAGE DISORDERS IN CHILDREN (2) Nature, etiology, diagnosis, and management of language disorders in children. Prerequisites: Cm.Dis. 400; 6 credits in communication disorders or related fields such as psychology, linguistics, or human development.

## COMMUNICATION DISORDERS

550. SEMINAR IN COMMUNICATION DISORDERS (1-6) Advanced study of special problems and new developments in communication disorders. Prerequisites: 10 credits in communication disorders.
560. RECENT DEVELOPMENTS IN EDUCATION OF THE DEAF (2-6) In-depth seminar-style study of communication disorders associated with deafness, and advanced and experimental attempts at remediation. Prerequisites: 8 credits in education of the deaf or audiology; Cm.Dis. 430, 433; 3 credits in child development or learning theory.
561. CLINICAL PROCEDURES FOR TEACHING SPEECH TO THE HEARING IMPAIRED (3) An applications course providing demonstrations of techniques and practices, and instruction on how to apply such information in therapeutic situations. Prerequisite: Cm.Dis. 460.
565. INTEGRATING LANGUAGE AND READING FOR HEARING IMPAIRED CHILDREN (3) Theoretical bases and practical applications of an integrated approach to language and reading instruction for hearing impaired children. Prerequisites: Cm.Dis. 463, RCLEd. 400.
566. EFFECTS OF HEARING IMPAIRMENT ON COGNITIVE AND SOCIAL DEVELOPMENT (3) Effects of hearing impairment on developmental, educational, social, and vocational adjustment; assisting the hearing impaired toward improved life adjustment. Prerequisites: Cm.Dis. 430, 433.
567. AUDIOLOGY FOR HEARING AND SPEECH CLINICIANS (3) Etiology, measurement, and differential diagnosis of hearing loss; overview of aural rehabilitation, including hearing aids and auditory training systems. Prerequisites: Cm.Dis. 430, 433; 6 credits in speech pathology and audiology.
568. LINGUISTIC ASPECTS OF AMERICAN SIGN LANGUAGE (3) Study of the linguistic principles of American sign language, including syntactic, nonphonological, semantic, and pragmatic aspects. Prerequisite: Cm.Dis. 468.
572. PSYCHOACOUSTICS IN COMMUNICATION DISORDERS (4) Perceptual phenomena of normal audition supported by reviews of methods and principles of psycho-physical measurement and of hearing theory. Prerequisites: 6 credits of acoustics or communication disorders.
573. PHYSIOLOGICAL ACOUSTICS IN COMMUNICATION DISORDERS (4) Overview of fundamental acoustics and application to anatomy and physiology of normal auditory systems. Prerequisites: 6 credits of acoustics or communication disorders.
574. PEDIATRIC AUDIOLOGY (3) Etiology, differential diagnosis, habilitation, and rehabilitation of hearing loss associated with infants, preschool, and school-age children. Prerequisite: Cm.Dis. 535 or 567.
575. SPECIAL AUDIOLOGICAL TESTS (3) Theory, administration, and interpretation of special audiological tests to determine the site of lesion of a hearing loss. Prerequisites: Cm.Dis. 533, 535.
- 595A. SPEECH THERAPY PRACTICUM (1-6) Theoretical and clinical rationale of therapy; professional role and relationships; therapy procedures; individual and group evaluation of process and outcomes. Prerequisites: Cm.Dis. 442, 495A.
- 595B. HEARING IMPAIRMENT PRACTICUM (1-6) Theoretical and clinical rationale of working with hearing impaired, professional role and relationships, therapy procedures, evaluation of process and outcomes. Prerequisite: Cm.Dis. 459B.
- 595C. SPEECH THERAPY INTERNSHIP (7-15) Full-time internship experience in speech therapy and diagnostic procedures at an off-campus site. Prerequisites: 30 credits in communication disorders.
- 595D. HEARING IMPAIRMENT INTERNSHIP (7-15) Full-time internship experience in procedures for teaching the hearing impaired at an off-campus site. Prerequisites: 30 credits in communication disorders.
- 595E. AUDIOLOGY PRACTICUM (1-5) Prerequisite: Cm.Dis. 531.
- 595F. AUDIOLOGY INTERNSHIP (7-15) Full-time internship experience in audiologic procedures at an off-campus site selected by the Cm.Dis. program staff. Prerequisites: 30 credits in communication disorders.
- 595G. SPEECH DIAGNOSTICS PRACTICUM (1-3) Supervised practice in interviewing, counseling, speech evaluation, and synthesis of psychological, medical, and audiological data in speech diagnosis; report writing. Prerequisites: Cm.Dis. 444, 495A.
596. INDIVIDUAL STUDIES (1-9)



597. SPECIAL TOPICS (1-9)

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6) Prerequisites: 40 graduate credits in communication disorders.

## COMMUNITY SYSTEMS PLANNING AND DEVELOPMENT (CSP D)

R. RICHARD RITTI, *Chairman of Graduate Programs in Community Systems Planning and Development*  
S-210 Henderson Human Development Building  
814-863-2910

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Bruce Bullington, Ph.D. (California) *Associate Professor of Criminal Justice*  
Walter E. Freeman, Ph.D. (Michigan) *Professor of Human Development*  
Larry Gamm, Ph.D. (Iowa) *Associate Professor of Community Development*  
Laurie M. Gunter, Ph.D. (Chicago) *Professor of Nursing and Human Development*  
Vilma R. Hunt, A.M. (Radcliffe) *Professor of Environmental Health*  
Drew Hyman, Ph.D. (California) *Associate Professor of Community Development*  
Daniel Katkin, J.D. (Columbia) *Professor of Law*  
Stuart H. Mann, Ph.D. (Case Western Reserve) *Professor of Operations Research*  
Peter B. Meyer, Ph.D. (Wisconsin) *Associate Professor of Economic Planning*  
Joe A. Miller, Ph.D. (Michigan) *Associate Professor of Community Development*  
Marshall W. Raffel, Ph.D. (Victoria) *Professor of Health Planning*  
R. Richard Ritti, Ph.D. (Cornell) *Professor of Organizational Behavior*  
Bruce C. Stuart, Ph.D. (Washington State) *Associate Professor of Health Planning and Administration*  
Theodore R. Vallance, Ph.D. (Syracuse) *Professor of Human Development*  
Paul O. Woolley, Jr., M.D. (Yale) *Associate Professor of Health Planning*  
Carl E. Young, Ph.D. (Peabody) *Assistant Professor of Human Development*

### Associate Members of the Graduate Faculty

Thomas J. Bernard, Ph.D. (S.U.N.Y.) *Assistant Professor of Administration of Justice*  
John Blum, J.D. (Notre Dame) *Associate Professor of Health Planning and Administration*  
John Thomas Cirm, Ph.D. (Wisconsin) *Assistant Professor of Health Planning and Administration*  
Frederick R. Eisele, Ph.D. (New York) *Associate Professor of Social Policy*  
Earl S. Elliott, Ph.D. (Kansas) *Assistant Professor of Human Development*  
Edward V. Ellis, Ph.D. (North Carolina) *Associate Professor of Public Health*  
Frederick E. Fisher, Ph.D. (Southern California) *Associate Professor of Community Development*  
Lynne I. Goodstein, Ph.D. (C.U.N.Y.) *Assistant Professor of Administration of Justice*  
Henry L. Gutenplan, D.P.A. (New York) *Professor of Law Enforcement and Corrections*  
Philip Jenkins, Ph.D. (Cambridge) *Assistant Professor of History of Justice*  
John H. Kramer, Ph.D. (Iowa) *Associate Professor of Criminal Justice*  
Stephen Mastroski, Ph.D. (North Carolina) *Assistant Professor of Administration of Justice*  
Stanley P. Mayers, Jr., M.D. (Pennsylvania) *Professor of Health Care Planning*  
Andreas Muller, Ph.D. (S.U.N.Y.) *Assistant Professor of Health Planning and Administration*  
William H. Parsonage, M.A. (South Dakota) *Associate Professor of Administration of Justice*  
Judith Vicary, Ph.D. (Penn State) *Assistant Professor of Administration of Justice*

This interdisciplinary program provides instruction in content and research methods relating to the coordinated planning, development, administration, and evaluation of a range of community services in the three professional areas of health and medical care services, justice services, and community social services.

The aim of the program is to build the knowledge base and skills necessary to develop policies and programs for the effective delivery of human services to individuals and communities. Graduates of the program will be able to identify major community subsystems and recognize community problems and dysfunctions, expressing their relative seriousness in terms of economic and social costs. Graduates will have skill in working with members of the community and with community institutions to develop ways of coping with such problems and to facilitate the creation of interventions which will improve the quality of life. In addition, they will have the skills necessary to evaluate the effectiveness of these interventions.

The Ph.D. program prepares professionals, researchers, and teachers with the necessary concep-

tual and technical skills to identify and analyze elements of human service systems and to develop, implement, and evaluate programs designed to improve the quality of life. Ph.D. students will develop considerable understanding of all human service systems and might elect to develop a master's level competency in one of the professional areas represented in the program. The M.S. program will prepare individuals for professional-level work in health planning and administration, administration of justice, or community social services. Career opportunities include administration and planning positions in hospitals and health facilities, community mental health, social services, criminal justice planning agencies, courts, and corrections programs. Special research and training facilities include the Institute for the Study of Human Development and the University Computation Center.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Preference will be shown to applicants who have a broad background in the social sciences. Proficiency in quantitative skills such as mathematics and statistics is also desirable. In general, a 3.00 junior-senior average is expected of applicants, but consideration will be given to prior graduate education and professional work experience.

### Degree Requirements

A thesis is required for the M.S. degree. The communication requirements for the Ph.D. can be satisfied by demonstration of proficiency through examination in a foreign language or a set of computer languages.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## COMMUNITY SYSTEMS PLANNING AND DEVELOPMENT (CSP D)

500. INTRODUCTION TO COMMUNITY SYSTEMS PLANNING AND DEVELOPMENT (3) Introduction to applied general systems theory; applications to analysis of community systems and to the planning of community human services.

501. COMMUNITY SYSTEMS: STRUCTURE AND PROCESS (3) Classic and contemporary community organization theory, social planning and change, decision making, human services planning and action, community action, community research.

503. UNDERSTANDING ORGANIZATIONAL BEHAVIOR (3) A systematic application of the principles of organizational behavior to understanding professional roles in human service organizations.

504. INTERORGANIZATIONAL RELATIONS (3) Exploration of consequences of policy decisions and action in one or more social service systems on other community systems.

505. PROCESSES OF PLANNED CHANGE (3) A general systems approach to the assumptions beneath various social problem strategies and consequences associated with each intervention-set.

516. FORECASTING METHODS AND SOCIAL POLICY PLANNING (3) Analysis of predictive methods for forecasting social change. Prerequisites: Econ. 405, Stat. 200.

520. HEALTH CARE ORGANIZATION (3) Examination of health systems, organization, financing, and evaluation; trends, problems, and issues.

522A. HEALTH CARE TECHNOLOGY: PROCESSES OF HEALTH AND DISEASE (1) A review of the processes of health and disease, measurements, diagnostic criteria, and intervention strategies.

522B. HEALTH CARE TECHNOLOGY: THE TECHNOLOGIES OF PREVENTION (1) Health promotion and disease prevention from a technologic perspective, including physiologic, behavioral, and social/institutional technologies.



522C. **HEALTH CARE TECHNOLOGY: THE TECHNOLOGIES OF THERAPY AND REHABILITATION** (1) Technologic intervention on disease processes and rehabilitation: implications for clinical care, institutional management, and health sector planning.

524. **MANAGEMENT OF HEALTH SERVICES ORGANIZATIONS** (3) A systematic study of the roles of health services managers and the organizational and environmental context within which they work. Prerequisites: C.S.P.D. 503, 504.

525. **HOSPITAL AND HEALTH SERVICES ADMINISTRATION** (3) A study of decision making in hospitals and health organizations; the process of decision making, incorporating various techniques and strategies. Prerequisites: C.S.P.D. 520, 524, 535, Q.B.A. 511.

527. **APPROACHES TO HEALTH PLANNING** (3) A systematic exploration of approaches to health planning and an application of health planning techniques. Prerequisite: C.S.P.D. 531.

531. **HEALTH PROBLEM ANALYSIS** (3) Logic of empirical inquiry in study of community problems in health. Integration of theory and practice, technical data and values.

535. **FINANCIAL MANAGEMENT IN HEALTH INSTITUTIONS** (3) Financial environment of health institutions; financial aspects of management decision making; emphasis on revenue sources, budgeting, and cost control.

536. **HEALTH LAW** (3) The legal process as it applies to the health administrator, health organization, medical provider, and patient. Prerequisite: C.S.P.D. 520.

540. **VALUES AND GOALS IN THE ADMINISTRATION OF JUSTICE** (3) The justice system from perspective of clientele, service personnel, and the system. Meeting service requirements in community and institutional settings.

541. **SOCIAL PROCESSES IN CRIME AND THE ADMINISTRATION OF JUSTICE** (3) The development of crime and justice systems in light of theories of conflict and consensus.

542. **ADMINISTRATION OF CRIMINAL JUSTICE AGENCIES** (3) Administration and management techniques applied to justice settings, including decision making, communication, and career development.

543. **LEGAL ISSUES IN HUMAN SERVICES ADMINISTRATION** (3) Examination of constitutional and administrative law principles relevant to the administration of human service agencies.

560. **ISSUES AND TRENDS IN THE DEVELOPMENT OF SOCIAL WELFARE SERVICES** (3-6) Examination of selected issues affecting the development of social welfare functions and services.

590. **COLLOQUIUM** (1-3)

596. **INDIVIDUAL STUDIES** (1-9)

597. **SPECIAL TOPICS** (1-9)

602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING** (1-3 per semester, maximum of 6)

## COMPARATIVE LITERATURE (C LIT)

CAROLINE D. ECKHARDT, *In Charge of Graduate Programs in Comparative Literature*  
N424 Burrowes Building  
814-863-0589

**Degrees Conferred:** Ph.D., M.A.

### Senior Members of the Graduate Faculty

John A. Balaban, M.A. (Harvard) *Professor of English*

Samuel P. Bayard, M.A. (Harvard) *Professor Emeritus of English and Comparative Literature*

Michael H. Begnal, Ph.D. (Washington) *Professor of English and Comparative Literature*

Robert W. Carrubba, Ph.D. (Princeton) *Professor of Classics*

Ernst A. Ebbinghaus, Ph.D. (Marburg) *Professor of German*

Caroline D. Eckhardt, Ph.D. (Michigan) *Associate Professor of English and Comparative Literature*

Thomas A. Hale, Ph.D. (Rochester) *Associate Professor of French and Comparative Literature*

Alan E. Knight, Ph.D. (Yale) *Associate Professor of French*

W. LaMarr Kopp, Ph.D. (Penn State) *Professor of German*

Arthur O. Lewis, Ph.D. (Penn State) *Professor of English*

## COMPARATIVE LITERATURE

Robert F. Lima, Jr., Ph.D. (New York) *Professor of Spanish and Comparative Literature*  
Glyn P. Norton, Ph.D. (Michigan) *Associate Professor of French*  
Terry J. Peavler, Ph.D. (California) *Associate Professor of Spanish and Comparative Literature*  
Daniel Walden, Ph.D. (New York) *Professor of English*  
Patricia Ward, Ph.D. (Wisconsin) *Professor of French and Comparative Literature*  
Stanley Weintraub, Ph.D. (Penn State) *Research Professor of English*  
Paul West, M.A. (Columbia) *Professor of English and Comparative Literature*

### **Associate Members of the Graduate Faculty**

Earl Fitz, Ph.D. (C.U.N.Y.) *Assistant Professor of Spanish and Comparative Literature*  
Robert Ginsberg, Ph.D. (Pennsylvania) *Professor of Philosophy*  
Stephen R. Grecco, M.F.A. (Yale) *Associate Professor of English*  
Linda J. Ivanits, Ph.D. (Wisconsin) *Assistant Professor of Russian*  
Christiane P. Makward, Docteur es Lettres (Paris) *Associate Professor of French*  
John W. Moore, Jr., Ph.D. (Stanford) *Assistant Professor of English*  
Peter H. Schneeman, Ph.D. (Minnesota) *Associate Professor of English and Comparative Literature*  
Gerhard F. Strasser, Ph.D. (Brown) *Assistant Professor of German*  
Kenneth A. Thigpen, Ph.D. (Indiana) *Associate Professor of English and Comparative Literature*  
Emily Toth, Ph.D. (Johns Hopkins) *Assistant Professor of English*

Graduate programs in Comparative Literature are designed to permit advanced study in several departments along with integrative courses in the Comparative Literature program. Both the M.A. and the Ph.D. combine a small core of Comparative Literature requirements with courses in national literatures and further Comparative Literature courses, according to each student's interests. For example, programs of study can concentrate on such topics as genres, themes, periods, movements, folklore, criticism, and the links between literature and related fields such as theatre or film.

The M.A. is a general humanistic degree that prepares students for a variety of situations, including teaching in private high schools or community colleges, or further graduate work. The Ph.D. is a more specialized degree. The Ph.D. in Comparative Literature can be combined with a minor in a professional field such as teaching English as a second language.

Only the faculty members and courses officially associated with the Comparative Literature program are listed here. The full range of faculty members and courses in related departments will also be available to Comparative Literature students according to their preparation.

### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Students with a 3.00 junior-senior average and appropriate course backgrounds will be considered for admission. Most students who do graduate work in comparative literature hold a B.A. or M.A. degree in a national language and literature. Students completing degrees in such fields are welcome to apply — as are students in other humanistic fields, such as philosophy or history, if they have studied literature.

For admission to the M.A. program, students should be prepared to study at least one foreign literature in its own language; for admission to the Ph.D. program, students should be prepared to study at least two foreign literatures in their own language. Students are not admitted directly from the B.A. to the Ph.D. level but should complete the M.A. before being formally admitted to the Ph.D. program.

### **Master's Degree Requirements**

Requirements for the M.A. in Comparative Literature include (1) C.Lit. 501; (2) 6 further credits in Comparative Literature courses; (3) 9 credits in one national literature and 6 credits in a second national literature; (4) proficiency in two foreign languages; (5) a written comprehensive examination based on a reading list; and (6) a 6-credit thesis.

On item (4), one of the foreign languages is to be at the level that permits thorough literary analysis of texts in that language; the second foreign language may be prepared at reading proficiency only.



**Doctoral Degree Requirements**

Requirements for the Ph.D. in Comparative Literature include (1) C.Lit. 501, 502, and 503 — with substitute courses if these have been used in the M.A. program; (2) at least 21 credits in either a concentration in three national literatures, or a concentration in a period, genre, theme, or area study; (3) an oral candidacy examination; (4) proficiency in three foreign languages; (4) a written comprehensive examination based on a reading list; and (5) a dissertation.

On item (3), two of the foreign languages are to be prepared at a level that permits thorough literary analysis of texts in those languages; the third foreign language may be prepared at reading proficiency only.

**Other Relevant Information**

The Comparative Literature program is a medium-sized graduate program offered in cooperation with the departments of languages and literatures at Penn State. Students taking Comparative Literature degrees have individualized programs of study within the requirements specified above. For example, one student may emphasize drama; another, novel. One student may concentrate on earlier literatures; another, on modern. One student may be interested primarily in the European tradition; another, in the New World (or "Inter-American") literatures. In such a program, the relationship between student and adviser is important. Each graduate student works with faculty advisers (a general adviser and a thesis or dissertation adviser) familiar with comparative studies as a whole and with the student's particular area of interest.

**Student Aids**

Teaching assistantships in Comparative Literature, as well as in related language and literature departments, typically have been available to students in Comparative Literature. In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

EDWIN ERLE SPARKS DISSERTATION FELLOWSHIP IN THE HUMANITIES — Available to a doctoral candidate in one of the following graduate programs: classics, comparative literature, English, French, German, history, linguistics, philosophy, religious studies, Slavic languages and literatures, Spanish, and speech communication; stipend \$4,800 plus tuition. Apply to relevant department or program before February 1.

EDWIN ERLE SPARKS FELLOWSHIPS IN THE HUMANITIES (8) — Available to beginning and continuing graduate students in one of the following graduate programs: classics, comparative literature, English, French, German, history, linguistics, philosophy, religious studies, Slavic languages and literatures, Spanish, and speech communication; stipend \$3,800 plus tuition. Apply to relevant department or program before February 1.

**COMPARATIVE LITERATURE (C LIT)**

- 400. SENIOR SEMINAR IN COMPARATIVE LITERATURE (3)
- 401. THE WESTERN LITERARY HERITAGE I (3)
- 402. THE WESTERN LITERARY HERITAGE II (3)
- 404. LITERARY MODES OF THE ORIENT (3)
- 405. INTER-AMERICAN LITERATURE (3)
- 408. HEROIC LITERATURE (3)
- 410. PROBLEMS IN TRANSLATION (3)
- 422. AFRICAN DRAMA (3) *Hale*
- 423. AFRICAN NOVEL (3) *Hale*
- 443. (Ger. 443) LITERARY RELATIONS OF GERMANY WITH ENGLAND AND AMERICA (3-9) *Kopp*
- 470. OLD MASTERS OF THE MODERN NOVEL (3)
- 480. THE INTERNATIONAL FOLKTALE (3)
- 483. (Film 483) FILM AND LITERATURE (3)
- 486. TRAGEDY (3) *Lima*
- 487. COMEDY (3) *Knight*
- 488. (Engl. 488) MODERN CONTINENTAL DRAMA (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
- 499. FOREIGN STUDY — COMPARATIVE LITERATURE (3-6)

## COMPUTER SCIENCE

501. **COMPARATIVE METHOD IN LITERARY STUDIES (3)** Bibliography, research methods, and studies in comparative literature. *Eckhardt and Ward*
502. **COMPARATIVE CRITICISM I: CLASSICAL TO NEOCLASSICAL (3)** Issues in literary criticism from Plato and Aristotle to the mid-eighteenth century. *Ward*
503. **COMPARATIVE CRITICISM II: ROMANTIC TO CONTEMPORARY (3)** Principles and theories of literary criticism from eighteenth- and nineteenth-century beginnings to twentieth-century expansion and application. *Ward*
504. **STUDIES IN LITERARY GENRES (3-6)** The concept of genre and the evolution of genre theory; application to a specific genre, e.g., the lyric or the novel.
505. **STUDIES IN LITERARY PERIODS AND MOVEMENTS (3-6)** Comparative approaches to cohesive units within literary history, e.g., the Renaissance, the Enlightenment, Romanticism, Surrealism.
506. **STUDIES IN LITERARY THEMES AND MOTIFS (3-6)** Comparative approaches to recurrent literary themes and motifs; application to a specific example, e.g. literary Utopias or the Faust theme.
508. **NORSE AND GAELIC SAGAS (3)** Medieval Irish and Scandinavian prose tales surveyed and compared with respect to background, development, themes, and characteristics. *Bayard and Ebbinghaus*
510. **THEORY AND PRACTICE OF TRANSLATION (3)** Theories of translation and interpretation; importance of translation in literary transmission; application of theoretical concepts to individual translation projects. Prerequisites: 24 credits in a foreign language.
543. **LITERARY RELATIONS (3 per semester, maximum of 6)** Mutual influences among specific literatures and cultures; for example, German-American, French-American, Inter-American, or East-West literary relations.
570. **FORCES IN CONTEMPORARY LITERATURE (3-6)** Intellectual currents and experimental forms in contemporary world literature.
590. **COLLOQUIUM (1-3)**
593. **ANGLO-AMERICAN FOLK SONG (3)** Survey of relevant literary and ethnological scholarship and field work, European and American, from the early sixteenth century to the present. *Bayard*
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**
599. **FOREIGN STUDY IN COMPARATIVE LITERATURE (1-12)** Graduate-level courses offered on comparative literary topics as part of a foreign-study experience approved by the program head. Prerequisites: 24 credits in the appropriate foreign language(s); 18 credits in literature or relevant related fields.

## COMPUTER SCIENCE (CMPSC)

JOSEPH M. LAMBERT, *Head of the Department*  
333 Whitmore Laboratory  
814-865-9505

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Jonathan Goldstine, Ph.D. (California, Berkeley) *Associate Professor of Computer Science*  
Joseph Ja'Ja', Ph.D. (Harvard) *Associate Professor of Computer Science*  
Donald B. Johnson, Ph.D. (Cornell) *Associate Professor of Computer Science*  
Donald T. Laird, Ph.D. (Penn State) *Associate Professor of Computer Science*  
Janos Simon, Ph.D. (Cornell) *Associate Professor of Computer Science*

### Associate Members of the Graduate Faculty

Helmut Alt, Ph.D. (Univ. Saarlandes) *Assistant Professor of Computer Science*  
Jesse Barlow, Ph.D. (Northwestern) *Assistant Professor of Computer Science*  
Greg N. Frederickson, Ph.D. (Maryland) *Associate Professor of Computer Science*  
Suchitra Gupta, Ph.D. (S.U.N.Y., Stony Brook) *Assistant Professor of Computer Science*  
Don E. Heller, Ph.D. (Carnegie-Mellon) *Assistant Professor of Computer Science*



Mary Jane Irwin, Ph.D. (Illinois) Assistant Professor of Computer Science  
 Gerald G. Johnson, Jr., Ph.D. (Penn State) Associate Professor of Computer Science  
 Joseph M. Lambert, Ph.D. (Purdue) Associate Professor of Computer Science  
 Sharon J. Laskowski, Ph.D. (Yale) Assistant Professor of Computer Science  
 Robert M. Owens, Ph.D. (Penn State) Assistant Professor of Computer Science  
 William Sakoda, Ph.D. (California, Berkeley) Assistant Professor of Computer Science  
 David W. Wall, Ph.D. (Stanford) Assistant Professor of Computer Science

The department offers courses and is prepared to direct research in a variety of subfields of computer science, including data bases and information retrieval, foundations of computer science, analysis of algorithms, computational complexity, formal language theory, operating systems, and numerical analysis. Research and instruction are supported by extensive computing facilities in the University's Computation Center and by the Computer Systems Laboratory operated by the department.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Admission to the M.S. program without deficiency requires that an applicant should have completed at least 9 credits of computer science at the advanced undergraduate level from the areas of data structures, programming languages and compiler design, computer organization and operating systems, numerical analysis, and language and automata theory. In addition, the student is expected to have mathematics training which includes calculus, linear algebra, and some discrete mathematics.

Students with at least a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. The department requires scores on the Graduate Record Examination Aptitude Test from all applicants.

### Master's Degree Requirements

The M.S. candidate must satisfactorily complete the requirements of the Graduate School. In addition, at least 12 of the required 500-level credits shall be regular courses in the Department of Computer Science meeting certain distribution requirements described in the departmental brochure "Graduate Study in Computer Science at Penn State." The nonthesis option is available for the M.S. degree. The candidate also may be required to demonstrate proficiency in the design and implementation of computer programs or computer-related systems, or both.

### Doctoral Degree Requirements

The Ph.D. degree is primarily a research degree and is conferred on the basis of original work and high academic achievement in computer science. In order to be accepted as a candidate, the student must pass a written candidacy examination. The communication and foreign language requirement for the Ph.D. degree may be satisfied by a proficiency in one foreign language (French, German, or Russian). These and additional requirements are detailed in the departmental brochure cited above.

### Other Relevant Information

Students in this program may elect the dual-title degree program option in Operations Research for the Ph.D. and M.S. degrees (see p. 285).

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

### COMPUTER SCIENCE (CMPSC)

- 403. ADVANCED PROGRAMMING FOR NONMAJORS (3)
- 408. (Chem. 408) COMPUTER APPLICATIONS IN CHEMISTRY (3)
- 410. COMPUTER ORGANIZATION AND OPERATION (3)
- 412. SYSTEMS PROGRAMMING (4)

- 415. (E.E. 415) COMPUTER SYSTEMS ARCHITECTURE (3)
- 430. COMBINATORICS AND GRAPH THEORY (3)
- 434. FUNDAMENTALS OF COMPUTER SCIENCE I (4)
- 435. FUNDAMENTALS OF COMPUTER SCIENCE II (4)
- 442. ADVANCED PROGRAMMING AND JOB CONTROL LANGUAGE (3)
- 444. SYSTEMS AND PROGRAM DESIGN IN EDP (3)
- 453. (Math. 453) NUMERICAL COMPUTATIONS (3)
- 454. (Math. 454) MATRIX COMPUTATIONS (3)
- 468. MATHEMATICAL MACHINE THEORY (3)
- 491. COMPUTER PROJECTS (1-12)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 500. THEORY OF AUTOMATA (3) The structure of finite automata and sequential machines, including characterization theorems, minimization problems, state identification experiments, and decomposition theory. Prerequisite: Cmp.Sc. 468.
- 510. PARSING, TRANSLATION, AND COMPILING (3) Principles of compiler design; lexical analysis, parsing methods, semantic analysis, code generation, and optimization. Prerequisite: Cmp.Sc. 468.
- 511. OPERATING SYSTEMS (4) Design and implementation of computer operating systems. Prerequisite: Cmp.Sc. 435 or 534.
- 515. ARCHITECTURE OF ARITHMETIC PROCESSORS (3) Algorithms and techniques for designing arithmetic processors; conventional algorithms and processor design; high-speed algorithms and resulting architectural structures. Prerequisite: Cmp.Sc. 415.
- 521. COMPILER CONSTRUCTION I (4) Design and implementation of compilers. Prerequisites: Cmp.Sc. 435, 534.
- 522. COMPILER CONSTRUCTION II (3) Advanced concepts in compiler design. Prerequisites: Cmp.Sc. 468, 521.
- 534. ALGORITHM DESIGN AND ANALYSIS (4) An introduction to algorithmic design and analysis. Prerequisite: graduate standing in Computer Science or Cmp.Sc. 435.
- 535. THEORY OF GRAPHS AND NETWORKS (3) Theory and applications of graphs, including structure of graphs, network analysis, and algorithms for computer solution of graph-theoretic problems. Prerequisites: Cmp.Sc. 430, 534.
- 537. (M.I.S. 537) MANAGEMENT INFORMATION SYSTEMS DESIGN (3) Cost, value, and technical considerations in analysis and design of information systems whose purposes are to aid decision making in organizations.
- 539. COMPLEXITY OF COMBINATORIAL PROBLEMS (3) NP-completeness theory; approximation and heuristic techniques; discrete scheduling; additional complexity classes. Prerequisite: Cmp.Sc. 430 or 534.
- 541. DATABASE MANAGEMENT SYSTEMS (4) Computer system organization for the management of data, data models, and implementation; primary and secondary key retrieval algorithms. Prerequisites: Cmp.Sc. 435 or 534.
- 542. INFORMATION PROCESSING SYSTEMS (3) Data structure and data processing; information retrieval systems. Prerequisite: Cmp.Sc. 541.
- 550. (Math. 550) NUMERICAL ALGEBRA (3) Zeros of polynomials; iterative solution of linear and nonlinear systems; sparse matrix techniques; eigenvalues and eigenvectors. Prerequisite: Cmp.Sc. (Math.) 454 or Math. 441.
- 551. (Math. 551) NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS (3) Methods for initial value and boundary value problems. Stability and convergence analysis, automatic error control, and stiff systems. Prerequisites: Cmp.Sc. (Math.) 453, Math. 411.
- 552. (Math. 552) NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS (3) Methods of parabolic, hyperbolic, and elliptic partial differential equations; finite difference and variational methods; splines, finite elements. Prerequisites: Cmp.Sc. (Math.) 453, 454; or Math. 405.



553. (Math. 553) **INTRODUCTION TO APPROXIMATION THEORY (3)** Interpolation; remainder theory; approximation of functions; error analysis; orthogonal polynomials; approximation of linear functionals; functional analysis applied to numerical analysis. Prerequisites: Math. 401; 3 credits in computer science.

559. **COMPUTABILITY AND RECURSIVE FUNCTIONS (3)** Mathematical treatment of computability, recursive functions, Turing machines, unsolvable problems, recursive and recursively enumerable sets. Prerequisite: Cmp.Sc. 468.

568-569. **THEORY OF FORMAL LANGUAGES AND AUTOMATA (3 each)** Generation and recognition of formal languages, grammars, Chomsky's hierarchy of languages, closure properties, characterization by automata, algebraic properties, complexity classification. Prerequisite: Cmp.Sc. 468.

579. (Math. 579) **SPECIAL TOPICS IN NUMERICAL ANALYSIS (2-12)**

581. **MACHINE INTELLIGENCE AND HEURISTIC PROGRAMMING (3)** Methods for making machines behave intelligently; problem solving, theorem proving, game playing, question answering, learning, induction; specialized languages and data structures. Prerequisite: Cmp.Sc. 521.

590. **COLLOQUIUM (1-3)**

596. **INDIVIDUAL STUDIES (1-9)**

597. **SPECIAL TOPICS (1-9)**

## COUNSELOR EDUCATION (CN ED)

EDWIN L. HERR, *Head of the Division of Counseling and Educational Psychology*  
327 Cedar Building  
814-865-3427

**Degrees Conferred:** Ph.D., D.Ed., M.S., M.Ed.

### Senior Members of the Graduate Faculty

Stanley B. Baker, Ph.D. (S.U.N.Y.) *Associate Professor of Education*  
Linda W. Craighead, Ph.D. (Penn State) *Assistant Professor of Education*  
Edwin L. Herr, Ed.D. (Columbia) *Professor of Education*  
John J. Horan, Ph.D. (Michigan State) *Professor of Education*  
George R. Hudson, Ed.D. (Columbia) *Professor of Education*  
Donald B. Keat II, Ph.D. (Temple) *Professor of Education*  
James W. Kelz, Ph.D. (Penn State) *Professor of Education*  
Thomas E. Long, D.Ed. (Penn State) *Professor of Vocational Education and Counselor Education*  
John D. Swisher, Ph.D. (Ohio State) *Professor of Education*

### Associate Members of the Graduate Faculty

Harold E. Cheatham, Ph.D. (Case Western Reserve) *Associate Professor of Education*  
Leila V. Moore, Ed.D. (S.U.N.Y.) *Assistant Professor of Counselor Education*  
Michael E. Scofield, Ph.D. (Wisconsin) *Assistant Professor of Education*  
Richard G. Swails, D.Ed. (Penn State) *Assistant Professor of Counselor Education*  
Eric R. White, Ed.D. (Pennsylvania) *Affiliate Assistant Professor of Education*

Professional preparation is offered at the master's level for school counselors (elementary and secondary), college counselors or persons entering college student personnel services, and rehabilitation counselors. Credits required by different master's options vary from 36 to 45. Doctoral programs prepare candidates for positions of responsibility and leadership in these same areas, as well as in the education of counselors, the management and supervision of counseling services, and counseling psychology.

### Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.

## COUNSELOR EDUCATION

All candidates for graduate degrees in Counselor Education must present for admission at least 27 undergraduate credits of 3.00 or better, distributed among at least three of the following areas: economics, education, psychology, sociology, and physiology or anatomy.

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests. Doctoral candidates should present at least a 3.33 average in all graduate study completed.

### **Degree Requirements**

All candidates are expected to exhibit, in addition to academic competence, effectiveness in interpersonal relations and in both written and oral communication. They also must evidence support of professional counseling activities and organizations. All degree options require students to participate in extensive practicum, field work, or internship experience under supervision.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by a comprehensive knowledge of one foreign language and courses from other designated areas, or by options from designated areas selected to include competence in statistics, research design, computer application, or measurement.

### **Student Aids**

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## **COUNSELOR EDUCATION (CN ED)**

- 403. FOUNDATIONS OF GUIDANCE AND COUNSELING PROCESSES (3)
- 404. GROUP PROCEDURES IN GUIDANCE AND COUNSELING (3)
- 408. INTRODUCTION TO VOCATIONAL REHABILITATION (3)
- 409. MEDICAL INFORMATION FOR COUNSELORS (3)
- 410. REHABILITATION OF THE MENTALLY ILL (3)
- 412. REHABILITATION FACILITIES AND SERVICES OF PENNSYLVANIA (3)
- 413. REHABILITATION CASE RECORDING AND MANAGEMENT (3)
- 415. COUNSELING ADULTS (3)
- 417. (Voc.Ed. 417) CAREER EDUCATION: ORIGINS, THEORY, IMPLEMENTATION (3)
- 425. THE USE OF TESTS IN COUNSELING (3)
- 470. WORKSHOP IN STUDIES IN COUNSELOR EDUCATION (1-6)
- 495A. FIELD WORK IN VOCATIONAL HABILITATION (12-18)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 501. COUNSELING THEORY AND METHOD (3) Survey of psychodynamic, rational, and behavioral approaches to counseling individuals, with particular emphasis on problems of choice.
- 502. ADVANCED COUNSELING THEORY AND METHOD (3) Assessment, intervention, and evaluation procedures for counseling problems frequently encountered in school, college, and rehabilitation settings. Prerequisite: Cn.Ed. 501.
- 503. GUIDANCE SERVICES IN ELEMENTARY EDUCATION (3) Guidance services to elementary school students; guidance opportunities for elementary teachers and principals.
- 504. GUIDANCE SERVICES IN SECONDARY EDUCATION (3) Nature and scope of guidance in secondary schools — services, models, and strategies; the counselor as an agent of change.
- 505. FOUNDATIONS OF COUNSELING INFORMATION (3) Accelerating change in economic, psychological, social, educational influences upon counselees. Utilization of information systems in effecting counselee change.
- 506. INDIVIDUAL ANALYSIS AND COUNSELING PROCEDURES (3) Collection and use of data basic to the counselor's understanding of individuals; the counseling interview and techniques other than testing. Prerequisite: Cn.Ed. 501.
- 508. ORGANIZATION AND ADMINISTRATION OF GUIDANCE PROGRAMS (3) Principles, organization, personnel, functions, integration with school programs, evaluation.



509. **CONTRIBUTIONS OF PROFESSIONAL PERSONNEL TO VOCATIONAL REHABILITATION (3)** Contributions of medical, social, psychological, and other specialists through the team approach; professional ethics, medical problems. Prerequisite: Cn.Ed. 408.
551. **STUDENT PERSONNEL SERVICES (2-3)** Student personnel services in higher education; organization of student advisory programs; use of personnel data; cocurricular activities; student welfare.
553. **STUDENT PERSONNEL SERVICES PROGRAMMING (2-3)** Formulation of policies as guides to the student personnel service programs; integration of program elements; research; current problems and trends. Prerequisite: Cn.Ed. 551.
555. **CAREER COUNSELING (3)** The examination of historical, legislative, and current models of career counseling and the development of pertinent individuals and group techniques. Prerequisite: Cn.Ed. 505.
591. **SEMINAR IN COUNSELING: HISTORY AND TRENDS (1)** Discussion of the history of guidance and counseling, emphasizing how the past has shaped the present and portends the future. Prerequisites: 9 credits in counselor education.
592. **SEMINAR IN COUNSELING: LEGAL AND ETHICAL CONCERNS (1-2)** Study and discussion of legal, ethical, and professional concerns of counselors; privileged communication, data banks, and privacy invasion. Prerequisites: 9 credits in counselor education.
593. **SEMINAR IN COUNSELING: PHILOSOPHY (1)** Study and discussion of such philosophical foundations of counseling as phenomenology, idealism, realism, existentialism, daseinanalytic, theological, and other contemporary thoughts. Prerequisites: 9 credits in counselor education.
594. **RESEARCH IN COUNSELING (2-6)** The design, implementation, and evaluation of counseling research projects. Prerequisites: Cn.Ed. 425, 501, 505. Prerequisite or concurrent: Ed.Psy. 506.
- 595A. **COUNSELING PRACTICUM (1-6)** Practice in the application of guidance principles and methods to cases counseled under supervision; case conferences; seminar in guidance techniques. Prerequisites: Cn.Ed. 425, 505, 506.
- 595B. **SUPERVISED PRACTICUM IN REHABILITATION COUNSELING (1-6)** Application of principles and techniques of rehabilitation counseling to cases involving handicapped individuals. Prerequisites: Cn.Ed. 408, 425, 505, 506.
- 595C. **PROFESSIONAL EXPERIENCE IN REHABILITATION COUNSELING (1-15)** Supervised internship, with responsibility for a regular case load. Prerequisites: Cn.Ed. 409, 595B.
- 595D. **SUPERVISION OF COUNSELORS (3-9)** Practical experience in supervising and evaluating work of counselors. Prerequisite: Cn.Ed. 595A or 595B.
- 595E. **ELEMENTARY SCHOOL COUNSELING INTERNSHIP AND SEMINAR (1-2 per semester, maximum of 6)** Off-campus, supervised internships in elementary school settings with supplementary related topics, discussion, and skills training in on-campus seminars. Prerequisite or concurrent: Cn.Ed. 503.
- 595F. **SECONDARY SCHOOL COUNSELING INTERNSHIP AND SEMINAR (1-2 per semester, maximum of 6)** Off-campus, supervised internships in secondary school settings with supplementary related topics, discussion, and skills training seminars. Prerequisite or concurrent: Cn.Ed. 504.
- 595G. **STUDENT PERSONNEL INTERNSHIP AND INTEGRATIVE SEMINAR (1-6 per semester, maximum of 9)** Off-campus, supervised internships in postsecondary-related college-student personnel settings with pertinent topics, discussion; skills training seminars on campus. Prerequisite or concurrent: Cn.Ed. 551.
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**
602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)**

## CURRICULUM AND INSTRUCTION (C I)

ROBERT L. SHRIGLEY, *Professor in Charge, Graduate Programs in Curriculum and Instruction*  
157 Chambers Building  
814-865-5433

**Degrees Conferred:** Ph.D., D.Ed., M.S., M.Ed.

### Senior Members of the Graduate Faculty

Joseph V. Alessandro, D.Ed. (Penn State) *Professor of Education*  
Eunice N. Askov, Ph.D. (Wisconsin) *Professor of Education*  
Paul E. Bell, D.Ed. (Oregon) *Associate Professor of Education*  
Emery P. Bliesmer, Ph.D. (Iowa State) *Professor of Education*  
Carol A. Cartwright, Ph.D. (Pittsburgh) *Professor of Education*  
Mary M. Dupuis, Ph.D. (Penn State) *Associate Professor of Education*  
Victor L. Dupuis, Ph.D. (Purdue) *Professor of Education*  
Francis M. Dwyer, Jr., D.Ed. (Penn State) *Professor of Education*  
Edward R. Fagan, Ed.D. (Columbia) *Professor of Education*  
H. Seymour Fowler, Ph.D. (Cornell) *Professor of Education*  
Lester S. Golub, Ph.D. (Stanford) *Professor of Education*  
Ralph T. Heimer, D.Ed. (Penn State) *Professor of Education*  
Henry J. Hermanowicz, Ed.D. (Columbia) *Professor of Education*  
Jane M. Madsen, Ed.D. (Arizona State) *Associate Professor of Education*  
Murry R. Nelson, Ph.D. (Stanford) *Associate Professor of Education*  
Joseph O. Prewitt-Díaz, Ph.D. (Connecticut) *Assistant Professor of Education*  
John E. Searles, Ed.D. (Stanford) *Professor of Education*  
Edmund C. Short, Ed.D. (Columbia) *Associate Professor of Education*  
Robert L. Shrigley, D.Ed. (Penn State) *Professor of Education*  
Cecil R. Trueblood, D.Ed. (Penn State) *Professor of Education*  
Paul W. Welliver, Ph.D. (Penn State) *Professor of Education*  
Fred H. Wood, D.Ed. (Missouri) *Professor of Education*  
Thomas D. Yawkey, Ph.D. (Illinois) *Associate Professor of Education*

### Associate Members of the Graduate Faculty

Anton Glaser, D.Ed. (Temple) *Professor of Mathematics*  
Lee F. Goldsberry, Ed.D. (Illinois) *Assistant Professor of Education*  
James H. Hogg, D.Ed. (Penn State) *Associate Professor of Education*  
Donald W. Johnson, Ed.D. (Colorado) *Professor of Education*  
Joyce Lee, D.Ed. (Penn State) *Assistant Professor of Education*  
Robert F. Nicely, Jr., Ph.D. (Pittsburgh) *Associate Professor of Education*  
Martin W. Sharp, Jr., D.Ed. (Penn State) *Assistant Professor of Education*  
Michael J. Streibel, Ph.D. (Wisconsin) *Assistant Professor of Education*

This program provides advanced professional preparation in the special areas of supervision and curriculum development, bilingual education, early childhood education, elementary education, instructional systems, language arts and reading, science education, social studies education, and mathematics education.

The M.Ed. program is also available at the King of Prussia Center for Graduate Studies and Continuing Education.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Students with appropriate course and professional backgrounds will be considered for admission, subject to the limitation of program facilities. For admission to the professional degree programs leading to the M.Ed. and D.Ed., teaching or equivalent experience and at least 18 credits in education are recommended.



**Master's Degree Requirements**

M.Ed. and M.S. candidates are expected to complete the core: Ed.Psy. 421, C.I. 400, and C.I. 550, or the equivalent.

Candidates for the M.Ed. degree with a minor in Curriculum and Instruction must take a minimum of 6 course credits approved in advance.

**Doctoral Degree Requirements**

The completion of a core of competencies in curriculum, instruction, and supervision is expected of Ph.D. and D.Ed. candidates.

To meet residency requirements, the Ph.D. candidate must spend at least two consecutive semesters enrolled as a full-time student at the University Park Campus. The D.Ed. candidate must spend at least two consecutive sessions (e.g., semester, summer session) enrolled as a full-time student at the University Park Campus. The communication and foreign language requirement for the Ph.D. degree may be satisfied by completing two of the following options: foreign language, statistics, computer science and technology, linguistics, ethnography, demography, historiography, or technical writing.

Candidates for the D.Ed. degree with a minor in Curriculum and Instruction must take a minimum of 15 course credits approved in advance by the professor in charge of graduate programs in Curriculum and Instruction.

**Student Aids**

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

**CURRICULUM AND INSTRUCTION (C I)**

- 400. INTRODUCTION TO RESEARCH LITERATURE (3)
- 408. METHODS OF TEACHING BASIC SKILLS (4-6)
- 409. INSTRUCTIONAL DESIGN, DEVELOPMENT, AND EVALUATION (4)
- 411. SECONDARY TEACHING I (3)
- 412. SECONDARY TEACHING II (3)
- 495A. CLINICAL APPLICATION OF INSTRUCTION AND MANAGEMENT SKILLS (3 per semester, maximum of 6)
- 495B. PRACTICUM IN STUDENT TEACHING — N-12 (12-15)
- 495C. PROFESSIONAL DEVELOPMENT PRACTICUM (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 550. OVERVIEW OF CONTEMPORARY SCHOOL CURRICULUM (3) Current school programs and options and their impact on pupils; problems in introducing new content into the curriculum. Prerequisites: 12 credits in education and psychology or teaching experience.
- 590. COLLOQUIUM (1-3)
- 595. INTERNSHIP IN CURRICULUM, SUPERVISION, OR INSTRUCTION (1-6) Internship in schools or other educational settings under supervision of graduate faculty in the student's area of specialization. Prerequisites: approval by program; at least 15 graduate-level credits in education.
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

**CURRICULUM AND SUPERVISION (C & S)**

- 401. MEASUREMENT AND EVALUATION OF INSTRUCTION, K-12 (3)
- 405. STRATEGIES IN CLASSROOM MANAGEMENT (3)
- 451. INSTRUCTION IN EARLY CHILDHOOD EDUCATION DERIVED FROM DEVELOPMENTAL THEORIES (4)
- 452. ANALYSIS OF MODEL EARLY CHILDHOOD EDUCATION PROGRAMS (3)
- 453. PARENT INVOLVEMENT IN HOME, CENTER, AND CLASSROOM INSTRUCTION, N-12 (3)
- 454. (I.F.S. 454) DEVELOPMENT AND ADMINISTRATION OF CHILD SERVICE PROGRAMS (3)
- 470. WORKSHOP IN SELECTED STUDIES IN CURRICULUM (1-6)
- 471. WORKSHOP IN SELECTED STUDIES IN SUPERVISION (1-6)

## CURRICULUM AND INSTRUCTION

- 479. THE YOUNG CHILD'S PLAY AS EDUCATIVE PROCESSES I (4)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

551. CURRICULUM DESIGN: THEORY AND PRACTICE (3) The analysis and use of the foundations which underlie models of curriculum design. Prerequisite: C.I. 550.

553. ISSUES AND TRENDS IN SCHOOL PROGRAMS (3 per semester, maximum of 6) In-depth study of issues and trends in designing comprehensive programs at either the elementary, middle, or high school level. Prerequisites: 12 graduate credits in education.

554. LONG-RANGE PLANNING FOR SCHOOL PROGRAMS (3) Strategies and techniques for conducting long-range planning of educational programs. Prerequisite: C.&S. 551 or C.I. 550.

555. DEVELOPMENT OF TEACHER EDUCATION PROGRAMS (3) Study of the components and design of teacher education programs within the constraints of institutional, professional, and legal contexts. Prerequisite: C.&S. 551 or C.I. 550.

557. SEMINAR IN CURRICULUM RESEARCH (3) Analysis of particular curriculum studies, methods and paradigms, and the general status of current research in the general curriculum field. Prerequisites: C.I. 400; 550.

558. STANDARD WORKS IN CURRICULUM AND INSTRUCTION (3) Study of significant empirical, historical, evaluative, philosophical, and critical works having an impact on curriculum and instruction practice. Prerequisite: C.&S. 551.

560. PRINCIPLES OF INSTRUCTIONAL SUPERVISION (3) Social and institutional settings for instructional supervision; functions, activities, and practices of supervision; supervisory case studies. Prerequisites: teaching or school administrative experience; 18 credits in education, at least 5 of which are methods of teaching.

561. METHODS OF CLINICAL SUPERVISION (3) A course in supervision for master teachers, department heads, and college teachers with supervisory responsibilities. Prerequisites: teaching experience; 18 credits in education, including at least 5 in methods.

562. SYSTEMATIC OBSERVATION OF INSTRUCTION (3) Construction and use of valid and reliable systematic observation systems used as a basis for classroom observation of instruction. Prerequisites: student teaching or teaching experience; C.&S. 560 or 561.

563. DESIGNING STAFF DEVELOPMENT PROGRAMS (3) Designing, implementing, and evaluating effective staff development programs for personnel in educational settings. Prerequisite: C.&S. 560.

572. ISSUES AND TRENDS IN EARLY CHILDHOOD EDUCATION (3 per semester, maximum of 9) Research, experimental programs, and emerging trends in early childhood education; relationships between educational experiences and later intellectual and emotional development. Prerequisites: C.&S. 452, Ed.Psy. 400.

589. THE YOUNG CHILD'S PLAY AS EDUCATIVE PROCESSES II (4) Child's play and gaming processes as assessment and diagnosis for readiness in early childhood education practicum with children. Prerequisite: C.&S. 479.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

## INSTRUCTIONAL SYSTEMS (INSYS)

- 411. ORIENTATION TO INSTRUCTIONAL SYSTEMS (2-3)
- 412. GRAPHICS AND PHOTOGRAPHY IN INSTRUCTION (3)
- 414. TELEVISION AND MOTION PICTURES IN INSTRUCTION (3)
- 415. SYSTEMATIC INSTRUCTIONAL DEVELOPMENT (3)
- 420. INDIVIDUALIZED INSTRUCTION (3)
- 440. INTRODUCTION TO COMPUTERS FOR EDUCATORS (3)
- 441. COURSE-AUTHORING LANGUAGES FOR EDUCATORS (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)



511. ORGANIZATION AND ADMINISTRATION OF INSTRUCTIONAL SYSTEMS (3) Procedures and considerations necessary for the effective organization, management, and evaluation of instructional systems. Prerequisite: In.Sys. 411.

520. FOUNDATIONS OF INSTRUCTIONAL SYSTEMS (3) An analysis of the applications of systems theory and information technology to instruction. Prerequisites: In.Sys. 411 or 415.

525. INSTRUCTIONAL SYSTEMS DESIGN (3) Advanced rational and empirical methods of analyzing and designing instructional systems. Prerequisite: In.Sys. 415.

532. RESEARCH IN INSTRUCTIONAL SYSTEMS (3) Review of recent research findings in instructional systems and their impact on the design of instruction. Prerequisite: Ed.Psy. 400.

540. COMPUTER-BASED INSTRUCTIONAL SYSTEMS (3) A survey of the theory and practice of using computers as instructional aids. Prerequisite: In.Sys. 440.

541. DESIGN AND DEVELOPMENT OF MICROCOMPUTER COURSEWARE (3) The design, development, and implementation of validated microcomputer courseware. Prerequisites: In.Sys. 441, 525, Cmp.Sc. 403.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

### **MATHEMATICS EDUCATION (MTHED)**

411. TEACHING SECONDARY MATHEMATICS I (3)

412. TEACHING SECONDARY MATHEMATICS II (3)

420. TEACHING MATHEMATICS IN THE ELEMENTARY SCHOOLS (3)

422. INDIVIDUALIZING INSTRUCTION IN SCHOOL MATHEMATICS (3)

424. CONTEMPORARY SCHOOL MATHEMATICS PROGRAMS (3)

427. COMPUTERS AND THE TEACHING OF MATHEMATICS (3)

470. SELECTED STUDIES IN MATHEMATICS EDUCATION (1-6)

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

520. ANALYSIS OF RESEARCH IN MATHEMATICS EDUCATION (3) Survey of the status of knowledge about mathematics learning and instruction, K-12; analysis of research procedures; instruments for evaluating research. Prerequisites: Mth.Ed. 420 or 412; 3 credits in statistics; teaching experience.

525. RESEARCH PARTICIPATION IN SCHOOL MATHEMATICS CURRICULUM CONSTRUCTION (3) Development of theoretical bases for the construction of instructional materials in mathematics, research participation in preparing and testing curriculum materials.

595. ADVANCED CLINICAL INTERNSHIP IN MATHEMATICS LEARNING (3) Supervised internship in advanced procedures for the implementation of diagnostic/prescriptive approaches as a strategy for improving mathematics learning. Prerequisites: 6 credits in mathematics education.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

### **READING, COMMUNICATION, AND LANGUAGE EDUCATION (RCLED)**

400. TEACHING READING IN THE ELEMENTARY SCHOOL (3)

401. METHODS OF TEACHING LANGUAGE ARTS IN ELEMENTARY SCHOOL (3)

402. TEACHING CHILDREN'S LITERATURE (3)

411. TEACHING SECONDARY ENGLISH I (3)

412. TEACHING SECONDARY ENGLISH II (3)

420. TEACHING READING AND LITERATURE TO ADOLESCENTS (3)

424. SEMINAR IN FOREIGN LANGUAGE AND BILINGUAL EDUCATION (3)

425. METHODS OF TEACHING IN BILINGUAL EDUCATION (3)

440. FUNDAMENTALS OF READING INSTRUCTION (3)

442. THE ELEMENTARY SCHOOL LANGUAGE ARTS PROGRAM (3)

443. TEACHING LANGUAGE AND COMPOSITION (3)

445. TEACHING ENGLISH IN BILINGUAL/DIALECTAL EDUCATION (3)

## CURRICULUM AND INSTRUCTION

- 446. REMEDIAL READING IN THE CLASSROOM (3)
- 450. CONTENT AREA READING (3)
- 467. INTERGROUP STORYTELLING (3)
- 470. SELECTED STUDIES IN READING, COMMUNICATION, AND LANGUAGE EDUCATION (1-6)
- 495. SCHOOL PRACTICUM IN READING (1-18)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 526. (Ed.Psy. 526) THE PSYCHOLOGY OF READING (3) Psychological principles underlying the process of reading and comprehending, with application to instruction. Prerequisite: Ed.Psy. 421.
- 540. TEACHING READING: LINGUISTICS PERSPECTIVE (3) Examination of reading as language and thought processes; contributions of linguistics, orthography, semantics, and syntax to instructional strategies. Prerequisites: undergraduate reading course and teaching experience.
- 541. CHILDREN'S LITERATURE RELATED TO ETHNIC AND SOCIAL ISSUES (3) Children's literature, K-12; study of literary symbolism, ethnic literature, and controversial issues; bibliotherapy, censorship, sex education through the trade book. Prerequisite: RCLEd. 402.
- 542. ISSUES IN READING, COMMUNICATION, AND LANGUAGE EDUCATION (3 per semester, maximum of 6) Issues in curriculum development and research in reading, communication, and language education, K-12; instructional materials analysis and development. Prerequisites: RCLEd. 412 and teaching experience.
- 544. CROSS-CULTURAL RESEARCH IN BILINGUAL EDUCATION (3) Analysis of cross-cultural research methodology in bilingual education. Prerequisites: 12 credits in education and/or psychology; 3 credits in statistics.
- 545. DIAGNOSTIC TESTING IN READING (4) Diagnosis of reading difficulties; genesis of reading problems; achievement, diagnostic, and capacity tests; application in required supervised practicum. Prerequisite: RCLEd. 440.
- 550. THEORY AND PRACTICUM IN REMEDIAL READING FOR ELEMENTARY STUDENTS (4) Remediation designs analyzed, applied, and evaluated in required supervised practicum with children. Prerequisite or concurrent: RCLEd. 440, 545; teaching experience.
- 551. THEORY AND PRACTICUM IN REMEDIAL READING FOR SECONDARY/ADULT LEARNERS (4) Reading problems of secondary/adult/remedial students based on theories and research; application in required supervised practicum. Prerequisites: RCLEd. 440, 545; teaching experience.
- 560. (Adt.Ed. 560) TEACHING READING TO COLLEGE STUDENTS AND ADULTS (3) Reading/literacy for adults, including college reading, Adult Basic Education (ABE), and General Educational Development (GED) programs. Prerequisite: RCLEd. 440 or teaching experience.
- 565. ANALYSIS OF THEORY AND PRACTICE IN BILINGUAL EDUCATION PROGRAM (3) Classroom analysis, observation, and research of instructional procedures, materials, and evaluation strategies used in bilingual education. Prerequisites: RCLEd. 424; 12 credits in education and psychology.
- 566. BILINGUAL EDUCATION AND THE HISPANIC CHILD (3) Analysis of the research and literature related to teaching bilingual Hispanic students; examines problems, issues, and strategies. Prerequisites: 12 credits in education and/or psychology.
- 594. RESEARCH IN THE TEACHING OF READING, COMMUNICATION, AND LANGUAGE EDUCATION (3) Cooperative study of problems and research findings in the teaching of reading, communication, and language education in American schools. Prerequisite: C.I. 400 or Ed.Psy. 400.
- 595A. PRACTICUM: REMEDIAL PROCEDURES AND DIAGNOSIS (3-6) Advanced practicum; diagnostic testing and remedial instruction of more severe types of reading disability; supervisory experiences, if appropriate. Prerequisite: RCLEd. 545.
- 595B. ADVANCED PRACTICUM IN BILINGUAL EDUCATION (1-6) Advanced internship in curriculum, supervision and instruction in bilingual education setting. Prerequisites: 12 credits in education and/or psychology; 12 credits in bilingual education.
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)



**SCIENCE EDUCATION (SCIED)**

- 411. TEACHING SECONDARY SCIENCE I (3)
  - 412. TEACHING SECONDARY SCIENCE II (3)
  - 454. SCIENCE IN EARLY CHILDHOOD EDUCATION (3)
  - 455. FIELD NATURAL HISTORY FOR TEACHERS (3)
  - 456. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE SCHOOLS (3)
  - 457. TEACHING OF ENVIRONMENTAL EDUCATION IN THE SCHOOLS (3)
  - 458. TEACHING SCIENCE IN THE ELEMENTARY SCHOOL (3)
  - 470. SELECTED STUDIES IN SCIENCE EDUCATION (1-6)
  - 496. INDEPENDENT STUDIES (1-18)
  - 497. SPECIAL TOPICS (1-9)
- 
- 556. THE SUPERVISION OF SCIENCE CURRICULUM (3) Supervision of elementary and secondary science teachers as they develop K-12 programs in the public schools. Prerequisites: 6 credits in science methods, 20 credits in science or equivalent, and teaching experience.
  - 558. RESEARCH PROBLEMS IN SCIENCE TEACHING (3) Problems and research dealing with curriculum, materials, evaluation, and supervision of science teaching and learning. Prerequisites: Sci.Ed. 412 or 458; teaching experience.
  - 559. ANALYSIS OF INSTRUCTION IN ELEMENTARY SCIENCE EDUCATION (3) Analysis of the history, issues, trends, and research in elementary science education. Prerequisites: teaching experience, 3 credits in elementary science methods, and 18 credits of science courses.
  - 596. INDIVIDUAL STUDIES (1-9)
  - 597. SPECIAL TOPICS (1-9)

**SOCIAL STUDIES EDUCATION (SS ED)**

- 411. TEACHING SECONDARY SOCIAL STUDIES I (3)
  - 412. TEACHING SECONDARY SOCIAL STUDIES II (3)
  - 430. TEACHING SOCIAL STUDIES IN THE ELEMENTARY GRADES (2-3)
  - 470. ISSUES IN SOCIAL STUDIES EDUCATION (1-6)
  - 496. INDEPENDENT STUDIES (1-18)
  - 497. SPECIAL TOPICS (1-9)
- 
- 530. INSTRUCTIONAL PRACTICES IN THE SOCIAL STUDIES (3) Social studies innovations in the classroom, new programs, new materials, new methods, and evaluation. Prerequisite: one year of teaching experience.
  - 532. CURRICULUM MODELS IN SOCIAL STUDIES EDUCATION (3) Study of past and proposed curricula in elementary and secondary social studies. Various means of judging curricula will be offered. Prerequisite: C.I. 495B.
  - 533. RESEARCH IN THE TEACHING OF SOCIAL STUDIES (3) Procedures and methods of research for the teaching of social studies, strategies of investigation, and review of research literature. Prerequisites: 12 credits in the social sciences on the 400 or 500 level and teaching experience.
  - 596. INDIVIDUAL STUDIES (1-9)
  - 597. SPECIAL TOPICS (1-9)

## DEVELOPMENTAL AND REMEDIAL READING (DRR)

ROBERT L. SHRIGLEY, *Professor in Charge, Graduate Programs in Developmental and Remedial Reading*

157 Chambers Building  
814-865-5433

**Degree Conferred:** M.Ed.

### Senior Members of the Graduate Faculty

Eunice N. Askov, Ph.D. (Wisconsin) *Professor of Education*

Emery P. Bliesmer, Ph.D. (Iowa State) *Professor of Education*

Mary M. Dupuis, Ph.D. (Penn State) *Associate Professor of Education*

Edward R. Fagan, Ed.D. (Columbia) *Professor of Education*

Lester S. Golub, Ph.D. (Stanford) *Professor of Education*

Jane M. Madsen, Ed.D. (Arizona State) *Associate Professor of Education*

The purpose of the master's program is to prepare classroom teachers in elementary and secondary schools for more effective teaching of reading and to provide preparation for supervisory and administrative positions relative to reading in school systems.

The master's program has been planned so that those completing the program will also meet the state requirements for "reading specialist" certification.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Candidates for a master's degree must meet the requirements for admission to graduate study. In addition, they (1) must hold, or be eligible to hold, a valid teaching certificate in elementary, secondary, or special education (persons not meeting this criterion may work on overcoming deficiencies; graduate credit, but not degree credit, may be received for graduate courses taken to overcome such deficiencies); and (2) must have had at least one year of teaching experience or equivalent.

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following award typically has been available to graduate students in this program:

U.S. OFFICE OF EDUCATION BILINGUAL EDUCATION FELLOWSHIPS — Available to Ph.D. and D.Ed. candidates preparing for professional careers in bilingual education or a related field; stipend \$6,000 plus tuition, books, and fees. Apply to Director, Bilingual Education Program, Division of Curriculum and Instruction, College of Education.



## EARTH SCIENCES (EARTH)

CHARLES THORNTON, *In Charge of Graduate Program in Earth Sciences*  
539 Deike Building  
814-865-4462

**Degrees Conferred:** D.Ed., M.Ed.

### Senior Members of the Graduate Faculty

Alfred K. Blackadar, Ph.D. (New York) *Professor of Meteorology*  
John J. Cahir, Ph.D. (Penn State) *Professor of Meteorology*  
John H. E. Clark, Ph.D. (Florida State) *Associate Professor of Meteorology*  
Roger J. Cuffey, Ph.D. (Indiana) *Professor of Paleontology*  
Frank Dachille, Ph.D. (Penn State) *Professor of Geochemistry*  
Rosa G. de Pena, Ph.D. (Buenos Aires) *Professor of Meteorology*  
John A. Dutton, Ph.D. (Wisconsin) *Professor of Meteorology*  
Charles L. Hosler, Ph.D. (Penn State) *Professor of Meteorology*  
Peter M. Lavin, Ph.D. (Penn State) *Associate Professor of Geophysics*  
Peirce F. Lewis, Ph.D. (Michigan) *Professor of Geography*  
John J. Olivero, Jr., Ph.D. (Michigan) *Associate Professor of Meteorology*  
Hans A. Panofsky, Ph.D. (California) *Evan Pugh Professor of Atmospheric Sciences*  
Robert F. Schmalz, Ph.D. (Harvard) *Professor of Geology*  
Dennis W. Thomson, Ph.D. (Wisconsin) *Professor of Meteorology*  
Charles P. Thornton, Ph.D. (Yale) *Professor of Petrology*  
Alfred Traverse, Ph.D. (Harvard) *Professor of Palynology*  
Frederick L. Wernstedt, Ph.D. (U.C.L.A.) *Professor of Geography*  
Eugene G. Williams, Ph.D. (Penn State) *Professor of Geology*  
Lauren A. Wright, Ph.D. (California Tech.) *Professor of Geology*

The M.Ed. program is designed to meet the needs of science teachers in elementary and secondary schools. The D.Ed. program is designed for secondary school and college science teachers. The earth science fields of study are geography, geological sciences (geology, geochemistry and mineralogy, or geophysics), and meteorology.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Students with a 2.50 junior-senior average, 18 credits in education and related psychology, and 6 credits in earth science fields or other appropriate background will be considered for admission to the M.Ed. program. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests. The M.Ed. program is not offered during the summer semester.

In order to enter the D.Ed. program a candidate should present evidence of competence at the baccalaureate level in one of the earth sciences (geography, geological sciences, or meteorology) or in an allied science curriculum. Students with a 2.70 junior-senior average and with appropriate course backgrounds will be considered for admission. Exceptions to the minimum 2.70 grade-point average will be made for students with special backgrounds, abilities, and interests.

### Master's Degree Requirements

The M.Ed. candidate selects one of the earth sciences as an area of concentration, takes at least 12 credits in it, and is required to write a paper in that area. An additional 12 credits must be taken in the other two fields of earth sciences; or 6 credits may be taken in one of the earth science fields plus 6 credits in other science or engineering fields. Two education courses, C.I. 400 and Sci.Ed. 558, are required as a minor.

### Doctoral Degree Requirements

The course requirements are planned by the candidate's committee. A minimum of 60 credits must include one area of concentration within the earth sciences — geography, geological sciences (geology, geochemistry and mineralogy, or geophysics), or meteorology — plus courses from each of the

other two earth science areas. A minimum of 15 credits each is required in professional education and in thesis research. The thesis topic must be in one of the earth sciences. Three consecutive semesters of residence are required for the D.Ed. degree. The student's D.Ed. committee shall normally consist of five members — two members from the area of concentration, one member from each of the other two earth science fields, and one member from education.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following award typically has been available to graduate students in this program:

**TEXACO FELLOWSHIP IN EARTH AND MINERAL SCIENCES** — Available to a graduate student in the College of Earth and Mineral Sciences; stipend \$1,200-3,000 plus tuition.

### EARTH SCIENCES (EARTH)

400. EARTH SCIENCES SEMINAR (3)

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

500. EARTH SCIENCES RESEARCH (1-6) Relationships between the earth sciences revealed by theory, analytical methods, or a selected problem.

## ECOLOGY (ECLGY)

EDWARD D. BELLIS, *In Charge of Graduate Programs in Ecology*  
311 Erwin W. Mueller Building  
814-865-3942

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Paul T. Baker, Ph.D. (Harvard) *Professor of Anthropology*  
Edward D. Bellis, Ph.D. (Minnesota) *Professor of Biology*  
Jean-Marc Bollag, Ph.D. (Basel) *Professor of Soil Microbiology*  
E. Alan Cameron, Ph.D. (California) *Associate Professor of Entomology*  
C. Seymour Card, Ph.D. (Colorado State) *Professor of Veterinary Science*  
Lester E. Casida, Jr., Ph.D. (Wisconsin) *Professor of Microbiology*  
Roger J. Cuffey, Ph.D. (Indiana) *Professor of Paleontology*  
Donald D. Davis, Ph.D. (Penn State) *Associate Professor of Plant Pathology*  
David R. DeWalle, Ph.D. (Colorado State) *Professor of Forest Hydrology*  
William A. Dunson, Ph.D. (Michigan) *Professor of Biology*  
H. B. Graves, Ph.D. (Virginia Polytech.) *Professor of Poultry Science*  
Albert L. Guber, Ph.D. (Illinois) *Associate Professor of Geology*  
Arthur A. Hower, Jr., Ph.D. (Penn State) *Professor of Entomology*  
Russell J. Hutnik, Ph.D. (Duke) *Professor of Forest Ecology*  
Carl S. Keener, Ph.D. (North Carolina State) *Associate Professor of Biology*  
Ke Chung Kim, Ph.D. (Minnesota) *Professor of Entomology*  
Jeffrey A. Kurland, Ph.D. (Harvard) *Assistant Professor of Anthropology*  
Archibald J. McDonnell, Ph.D. (Penn State) *Professor of Civil Engineering*  
Wayne L. Myers, Ph.D. (Michigan) *Associate Professor of Forest Biometrics*  
Ganapati P. Patil, Ph.D. (Michigan), D.Sc. *Professor of Mathematical Statistics*  
David L. Pearson, Ph.D. (Washington) *Associate Professor of Biology*  
Hansjakob Rothenbacher, Ph.D. (Michigan State) *Professor of Veterinary Science*  
Richard D. Schein, Ph.D. (California) *Professor of Botany*  
Robert D. Shipman, Ph.D. (Michigan State) *Professor of Forest Ecology*  
William E. Sopper, Ph.D. (Yale) *Professor of Forest Hydrology*  
Richard F. Unz, Ph.D. (Rutgers) *Associate Professor of Sanitary Microbiology*  
Frederick M. Williams, Ph.D. (Yale) *Associate Professor of Biology*  
Richard H. Yahner, Ph.D. (Ohio State) *Assistant Professor of Wildlife Management*

### Associate Members of the Graduate Faculty

Dean E. Arnold, Ph.D. (Cornell) *Assistant Professor of Biology*  
Stephen J. Beckerman, Ph.D. (New Mexico) *Assistant Professor of Anthropology*



John E. Burris, Ph.D. (California) *Assistant Professor of Biology*  
 Bruce G. Lindsay, Ph.D. (Washington) *Assistant Professor of Statistics*  
 James L. Rosenberger, Ph.D. (Cornell) *Associate Professor of Statistics*  
 Andrew G. Stephenson, Ph.D. (Michigan) *Assistant Professor of Biology*  
 Robin A. J. Taylor, Ph.D. (Imperial, London) *Assistant Professor of Entomology*

This intercollege program emphasizes the properties of ecosystems by focusing attention on interactions of single organisms, populations, and communities with their environment. It is designed to give students a basic understanding of ecological theory and research techniques and is complementary to other environmental programs which emphasize man's role in ecosystems.

The program is administered by a committee drawn from faculty members in several departments and colleges of the University. This committee and its chairman are appointed by the dean of the Graduate School. The instructional staff is composed of participating faculty in those departments offering graduate courses in fields closely allied to ecology.

The committee appointed by the Graduate School for each candidate in Ecology is selected from faculty in the student's area of specialization. The committee has the responsibility for determining the course program and research acceptable in satisfying degree requirements.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Students meeting the admission requirements of the Graduate School will be considered up to the number of spaces available in selecting candidates in this program. Candidates should have a strong science background, including chemistry through organic chemistry, mathematics through calculus, physics, and biology. Students with a unique background in another discipline which has potential value to original ecological work will be seriously considered. A junior-senior grade-point average of 3.00 or better is required.

Students are strongly urged to choose their research interests and initiate communication with the relevant faculty member(s) before applying for admission. This is especially crucial if the student is seeking financial aid. Teaching and research assistantships are available only through the student's faculty adviser.

Formal applications along with Graduate Record Examination scores including verbal, quantitative, and an advanced test should be sent to the Graduate School. The applicant should forward the following *directly to the program chairman*: (1) two or more letters of recommendation regarding the student's academic and professional promise; and (2) a concise one-page statement describing the student's goals both within the program and in professional life. Specific inquiries about the Ecology program may be directed to the program chairman.

### Degree Requirements

The instructional program includes three to five graduate core courses in ecology, augmented by an additional integrated group of seminars and courses selected for each student by the committee, and a research project directed by the thesis adviser. The nonthesis option is available for the M.S. degree, at the adviser's discretion.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of one foreign language.

### Other Relevant Information

Detailed descriptions of courses now available for students majoring in Ecology may be found under the offerings of several ecologically oriented departments.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## ECOLOGY (ECLGY)

590. COLLOQUIUM (1-3)

## ECONOMICS (ECON)

MONROE NEWMAN, *Head of the Department*  
613 Kern Graduate Building  
814-865-1456

**Degrees Conferred:** Ph.D., M.A.

### Senior Members of the Graduate Faculty

Edward C. Budd, Ph.D. (California) *Professor of Economics*  
Grant N. Farr, Ph.D. (California) *Professor of Economics*  
Irwin Feller, Ph.D. (Minnesota) *Professor of Economics*  
James B. Herendeen, Ph.D. (Penn State) *Professor of Economics*  
Teh-Wei Hu, Ph.D. (Penn State) *Professor of Economics*  
Philip A. Klein, Ph.D. (California) *Professor of Economics*  
Raymond E. Lombra, Ph.D. (Penn State) *Professor of Economics*  
Yash P. Mehra, Ph.D. (Minnesota) *Associate Professor of Economics*  
Jon P. Nelson, Ph.D. (Wisconsin) *Professor of Economics*  
Monroe Newman, Ph.D. (Illinois) *Professor of Economics*  
Jan S. Prybyla, Ph.D. (N.U., Ireland) *Professor of Economics*  
John H. Riew, Ph.D. (Wisconsin) *Professor of Economics*  
Warren C. Robinson, Ph.D. (Princeton) *Professor of Economics*  
James D. Rodgers, Ph.D. (Virginia) *Professor of Economics*  
Marvin E. Rozen, Ph.D. (California) *Professor of Economics*

### Associate Members of the Graduate Faculty

Eric W. Bond, Ph.D. (Rochester) *Assistant Professor of Economics*  
Robert M. Feinberg, Ph.D. (Virginia) *Associate Professor of Economics*  
Thomas G. Fox, Ph.D. (Syracuse) *Professor of Economics*  
Susan Pozo, Ph.D. (Michigan State) *Assistant Professor of Economics*  
Bee-yan Roberts, Ph.D. (Wisconsin) *Assistant Professor of Economics*  
Mark J. Roberts, Ph.D. (Wisconsin) *Assistant Professor of Economics*  
Richard Rosenberg, Ph.D. (Minnesota) *Associate Professor of Economics*  
Robert J. Rossana, Ph.D. (Johns Hopkins) *Assistant Professor of Economics*  
David Shapiro, Ph.D. (Princeton) *Assistant Professor of Economics*  
James B. Stewart, Ph.D. (Notre Dame) *Assistant Professor of Economics*  
Michael J. Wasylenko, Ph.D. (Syracuse) *Associate Professor of Economics*  
Nancy Wentzler, Ph.D. (Wisconsin) *Assistant Professor of Economics*

Opportunities are available for concentration in the following fields: economic analysis, economic doctrines, economic development of developed areas, economic development of underdeveloped areas, economic fluctuations, income distribution, industrial organization, international economics, comparative economic systems, labor economics, money and banking, public finance, quantitative economics, statistics, and regional economics.

Students also may qualify for admission to the program in population issues, consisting of interdisciplinary course work, with special emphasis on the economic, social, and geographic issues arising from the dynamics of population change.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

To enter graduate work in Economics a student should have completed at least 18 undergraduate credits in the fields of economics, accounting, commerce, and business statistics, including at least 6 credits in economics. All applicants must take the Graduate Record Examination in subject (advanced) tests and general (aptitude) tests.

Students with a 2.50 junior-senior average, a 3.00 average in courses in economics, and appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.



**Degree Requirements**

The nonthesis option is available for the M.A. degree. A student choosing the program option in Operations Research must complete a thesis.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by any of the following alternatives: (1) a reading knowledge of two foreign languages; (2) a reading knowledge of one foreign language and 6 credits of other course work from designated areas which increase research skills; (3) the equivalent of 12 credits of departmentally approved course work which increases research skills; or (4) a comprehensive knowledge of one foreign language.

**Other Relevant Information**

Students in this program may elect the dual-title degree program option in Operations Research for the Ph.D. and M.S. degrees (see p. 285).

**Student Aids**

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

**ECONOMICS (ECON)**

- 400. HISTORY OF ECONOMIC THOUGHT I (3)
- 401. HISTORY OF ECONOMIC THOUGHT II (3)
- 404. CURRENT ECONOMIC ISSUES (3)
- 405. SEMINAR IN ECONOMIC ANALYSIS (3)
- 412. LABOR MARKET POLICY AND COLLECTIVE BARGAINING (3)
- 423. STATE AND LOCAL TAXATION (3)
- 425. ECONOMICS OF PUBLIC EXPENDITURES (3)
- 427. (Ed.Adm. 427) ECONOMICS OF EDUCATION (3)
- 428. ENVIRONMENTAL ECONOMICS (3)
- 429. PUBLIC FINANCE AND FISCAL POLICY (3)
- 433. ADVANCED INTERNATIONAL ECONOMICS (3)
- 445. (H.P.A. 445) HEALTH ECONOMICS (3)
- 450. THE BUSINESS CYCLE (3)
- 451. MONETARY THEORY AND POLICY (3)
- 463. ECONOMIC DEMOGRAPHY (3)
- 480. MATHEMATICAL ECONOMICS (3)
- 489H. HONORS THESIS (3-6)
- 490. INTRODUCTION TO ECONOMETRICS (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
- 499. FOREIGN STUDY — ECONOMICS (2-6)
  
- 500. ECONOMIC SEMINAR (3-6)
- 502. MICROECONOMIC ANALYSIS (3) Economic behavior under pure and imperfect competition; price and output determination in product markets; prices and employment in factor markets.
- 503. MACROECONOMIC ANALYSIS (3) National income accounts; determination of income, employment, interest rates, and the price level; stabilization policy.
- 506. PROBLEMS IN ECONOMICS (1-12) Planned projects involving library, laboratory, or field work.
- 507. INTERNATIONAL TRADE (3) International trade and investment, commercial policy, trade and income distribution, multinational corporations in international trade, multinational corporations and international trade.
- 510. (Ag.Ec. 510) ECONOMETRICS I (3) General linear model, multicollinearity, specification error, autocorrelation, heteroskedasticity, restricted least squares, functional form, dummy variables, limited dependent variables. Prerequisite: Econ. 490 or Stat. 462 or 501.
- 511. (Ag.Ec. 511) ECONOMETRICS II (3) Stochastic regressors, distributed lag models, pooling cross-section and time-series data, simultaneous equation models. Prerequisite: Econ. (Ag.Ec.) 510.
- 513. DEVELOPMENT OF ECONOMIC DOCTRINES (3-6)

515. LABOR ECONOMICS I (3) Labor supply and income maintenance; human capital, job search and training; labor demand, minimum wage, and discrimination.
516. LABOR ECONOMICS II (3) Earnings differentials, unemployment, and related policy. Institutional aspects of labor economics, including dual labor markets, collective bargaining, and unionism.
517. INTERNATIONAL FINANCE (3) Balance of payments and methods of adjustment; economics of exchange rates; international liquidity and financial institutions; selected policy issues.
521. ADVANCED MICROECONOMIC THEORY (3-6) Theory of consumer behavior; theory of the firm; price determination in product and factor markets; introduction to welfare economics.
522. ADVANCED MACROECONOMIC THEORY (3-6) Measurement of income; theories of consumption, investment, and money holdings; static determination of income and employment; introduction to dynamic analysis.
524. INCOME DISTRIBUTION (3-6) Measurement of inequality; ethical issues of income redistribution; explaining income and wealth differences; problems of poverty.
525. ECONOMICS OF TECHNOLOGICAL CHANGE (3) Theoretical and empirical analysis of invention and innovation and their effects on productivity, employment, and market structure.
529. PUBLIC FINANCE (3-6) Effects of taxes, expenditures, debt on allocation, employment, distribution; cost-benefit analysis; collective decision mechanisms; fiscal federalism; current fiscal policy problems.
530. SPATIAL ECONOMIC THEORY (3) Location theory; analysis of market areas and spatial price behavior; central place theory.
531. REGIONAL ECONOMICS (3) Theories and analysis of levels of regional economic activity; growth policies and strategies; evaluation.
532. URBAN ECONOMICS (3) Urban structure; migration of capital and households; urban public finance.
543. INDUSTRIAL ORGANIZATION AND PUBLIC POLICY (3-6) The structure of American industry; performance and behavior; public policies toward business.
550. ECONOMIC FLUCTUATIONS (3) Analysis of the various theories of economic fluctuations; their methodological premises.
551. STABILIZATION POLICY (3) Description and analysis of the alternatives and issues in stabilization policy.
559. CURRENT MONETARY THEORY AND POLICY (3) Post-Keynesian reformulation of quantity and Keynesian theories of money; liquidity and general equilibrium approaches; current issues in theory and policy.
560. DEVELOPMENT ECONOMICS (3-6) Resources and institutions; quantitative measures; theories of economic growth in developing areas; developmental policies.
561. THEORIES OF AMERICAN ECONOMIC GROWTH (3-6) Growth models; strategic factors in growth; quantification problems; public policy.
571. COMPARATIVE ECONOMIC SYSTEMS (3-6) Comparative analysis of alternative resource allocation principles; growth and performance of different economic systems; problems of decision making and control.
572. SOVIET AND OTHER CENTRALLY PLANNED ECONOMIES (3-6) Principles, structure, and performance of centrally planned economies, with special emphasis on the Soviet Union.
580. MATHEMATICAL ECONOMICS (3-9) Mathematical development of static and dynamic economic models; partial and general equilibrium analysis; growth dynamics; mathematical programming. Prerequisite: Econ. 480.
588. DEVELOPMENT OF MONETARY THEORY (3) Classical and neoclassical quantity theories of money and contemporary criticism; Keynesian monetary theory and its critics.
595. (Ag.Ec. 595) SEMINAR IN ECONOMETRIC THEORY (3) Theories and methods relevant to the application of statistical methods to economics. Prerequisite: Econ. (Ag.Ec.) 510.
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)



## EDUCATIONAL ADMINISTRATION (EDADM)

DONALD J. WILLOWER, *Professor in Charge of Graduate Programs in Educational Administration*  
319 Rackley Building  
814-865-1487

**Degrees Conferred:** Ph.D., D.Ed., M.S., M.Ed.

### Senior Members of the Graduate Faculty

William Lowe Boyd, Ph.D. (Chicago) *Professor of Education*  
William E. Caldwell, Ph.D. (New York) *Associate Professor of Education*  
Patrick D. Lynch, Ph.D. (Minnesota) *Professor of Education*  
John M. Shernick, Ed.D. (Illinois) *Associate Professor of Education*  
Donald J. Willower, Ed.D. (Buffalo) *Professor of Education*

### Associate Members of the Graduate Faculty

Hugh W. Fraser, Ed.D. (Rochester) *Associate Professor of Education*  
Victor Levine, Ph.D. (Columbia) *Assistant Professor of Education*  
Grayson Noley, Ph.D. (Penn State) *Assistant Professor of Education*

Graduate work in Educational Administration is available to those who wish to exercise leadership roles in educational policy and management or engage in research. Among those roles are principals, supervisors, and superintendents of public and independent schools, intermediate unit officials, state and federal agency administrators and staff, professors of educational administration, and research and development personnel. Special areas of research are organization theory, school law, negotiations, personnel and staff development, economics and finance in education, application of modern technology, leadership, politics of education, and international comparative educational administration. Internships and practicums in private and public schools, educational systems, central offices, state and federal government agencies, intermediate units, or research laboratories can be arranged.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

The Miller Analogy Test is accepted in place of the Graduate Record Examination for admission to the graduate program in Educational Administration. Applicants to the M.Ed. and M.S. degree programs must present evidence of at least a 2.60 grade-point average in the last two years of undergraduate work. A grade-point average of 3.50 in prior graduate work is required of those desiring admission to enter a doctoral program. The best-qualified students will be accepted up to the number of spaces available for new students. Special backgrounds and experiences may allow for conditional admission to those not meeting stated criteria. Applicants for principalship certification in the state of Pennsylvania must hold teacher certification. Candidates may seek admission to a doctoral program without a master's degree.

More details concerning admission to and work in the degree and certification programs are presented in a program prospectus that is available upon request. Students in the M.S. and Ph.D. programs in Educational Administration may elect the dual-title degree program option in Operations Research (see p. 285).

### Master's Degree and Certification Requirements

All candidates for the M.Ed. and M.S. degrees will complete a minimum of 30 graduate credits. Certification for the principalship in Pennsylvania requires the completion of at least 45 graduate credits. An additional twenty-five hours are required for a superintendent's letter of eligibility. Certain state colleges in Pennsylvania offer in cooperation with the University work which leads to certification.

M.Ed. students must submit a master's paper as evidence of research and writing ability. Each paper is subject to review by the Graduate School. To receive the M.S. degree students are expected to submit a thesis related to the major field.

## Doctoral Degree Requirements

Candidates for the D.Ed. degree are required to spend at least one semester and one summer session consecutively in full-time residence during a twelve-month period. Ph.D. candidates are strongly encouraged to spend two academic years in residence, but must spend at least two consecutive semesters in residence, or one academic year. D.Ed. candidates may make application to satisfy the residence requirement in another manner consistent with Graduate School policy, if they can furnish satisfactory reasons for such a request. Candidates for all degrees are required to combine work in the social sciences and humanities with the specialization in Educational Administration.

Expectations of candidates for both the D.Ed. and Ph.D. are high in the field of research competence and require the ability to identify and conceptualize a research problem for the thesis. The D.Ed. is more appropriate for the goals of administration and policy making. The Ph.D. is taken by those who show exceptional research competence, and who can pursue independently a research problem which will clearly add to the body of knowledge in educational administration.

After the doctoral student has been admitted to a doctoral program and has completed forty to forty-five hours beyond the bachelor's degree, his or her name is usually submitted for candidacy by the graduate adviser. After a student is admitted to candidacy for the doctoral degree, he or she takes the comprehensive written and oral examinations. After those are successfully completed, the student presents a thesis problem on a significant, researchable topic, evidenced by a complete prospectus to the doctoral committee for review.

## Other Relevant Information

American Indian students participate in a special administrator preparation program. Foreign students can work on research topics in their home nations. All students work closely with advisers on research topics and programs.

## Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## EDUCATIONAL ADMINISTRATION (EDADM)

27. (Econ. 427) ECONOMICS OF EDUCATION (3)
30. INTRODUCTION TO EDUCATIONAL ADMINISTRATION (2-3)
31. COLLECTIVE BARGAINING IN EDUCATION (3)
96. INDEPENDENT STUDIES (1-18)
97. SPECIAL TOPICS (1-9)
25. FEDERAL POLICY AND LOCAL EDUCATION (3) Historic and contemporary roles of the federal government in education; includes proposal-writing techniques.
28. EDUCATIONAL POLITICS IN THE UNITED STATES (3) Social and institutional forces which shape the public school system and determine national, state, and local educational policy and politics.
33. THE POLITICS OF LOCAL SCHOOL DISTRICTS (3) Theory and practice of the politics and governance of local school districts; issues and methods in studying political decision making. Prerequisites: 6 credits of sociology, anthropology, or political science.
60. SYSTEM THEORY IN EDUCATION (3) Concepts of general system theory, the systems approach, and related methodologies and tools; applications in education; critique of instructional systems. Prerequisites: Ed.Psy. 400, 475.
65. PERSONNEL MANAGEMENT AND CONTRACT ADMINISTRATION (2-3) Practice and theory of personnel supervision at the central office and building level, including contract administration and grievance handling. Prerequisites: 18 credits in education and three years' teaching experience.
67. ORGANIZATIONAL SUPERVISION (3) Principles and practices of supervision in schools related to instructional and support personnel. Prerequisites: Ed.Adm. 480, teaching experience.
68. THE PRINCIPALSHIP (2-3) Principles and practices of administration of elementary and secondary schools.
69. DECISION MAKING IN EDUCATIONAL ORGANIZATIONS (2-3) Decision making in organizational and environmental contexts; case studies of administrative problems; application of decision-making models. Prerequisite: Ed.Adm. 480.



571. **EDUCATIONAL FACILITIES PLANNING (2-3)** Educational facilities planning, including use of demographic, curriculum, resource, energy data, and state building construction guidelines. Prerequisite: Ed.Adm. 480 or teaching or administrative or supervisory experience.
573. **PUBLIC SCHOOL FINANCE (2-3)** Financing of public education in relation to organization and control; the conceptual basis for local financial administration; taxation, state and federal aid, school revenue, and money management. Prerequisite: Ed.Adm. 480 or teaching or administrative or supervisory experience.
574. **THEORY AND CURRENT ISSUES IN PUBLIC BARGAINING (2-3)** Theories of bargaining; legal basis for public bargaining; state and federal labor relations agencies; supervisory bargaining. Prerequisite: Ed.Adm. 481 or administrative experience.
575. (Adt.Ed. 575) **ADMINISTRATION OF ADULT EDUCATION (3)** Organization of a program of adult education; legal status, finances, selection of teachers, learning personnel, housing, and other administrative problems. Prerequisite: Ed.Adm. 480 or teaching or administrative or supervisory experience.
576. **THE LAW AND EDUCATION (3)** Legal bases for education; rights and responsibilities of school board members, administrators, teachers, students, and parents; due process. Prerequisite: Ed.Adm. 480 or teaching or administrative or supervisory experience.
577. **ECONOMIC DIMENSIONS OF EDUCATIONAL ADMINISTRATION (3)** Application of selected economic concepts and tools of analysis to administrative decision and planning processes in educational systems. Prerequisite: Ed.Adm. 480.
578. **SCHOOLS AS ORGANIZATIONS (2-3)** Intraorganizational relationships; administration and the school in its organizational and environmental contexts. Prerequisite: Ed.Adm. 480 or teaching or administrative or supervisory experience.
579. **PUBLIC SCHOOL BUSINESS ADMINISTRATION (2-3)** Business management applied to school management problems; budgeting, accounting, purchasing, insurance, school equipment, cafeteria management; transportation, salaries, personnel management, and auxiliary and coordinate agencies. Prerequisites: Ed.Adm. 480 or teaching or administrative or supervisory experience; Ed.Adm. 573.
580. **THE USE OF THEORY IN EDUCATIONAL ADMINISTRATION (1-6)** Critical analysis of current theories; problem finding and hypothesis formulation. Prerequisites: Ed.Adm. 480; 6 credits in educational administration.
581. **FIELD RESEARCH IN EDUCATIONAL ADMINISTRATION (2-3)** Field study and qualitative methods in research on educational organizations. Prerequisites: Ed.Adm. 480; 6 credits in educational administration.
584. **EVALUATION IN EDUCATIONAL ORGANIZATIONS (3)** Naturalistic and empirical evaluation methods and procedures for educational organizations. Prerequisites: a course in educational administration; a course in basic statistics.
594. **SEMINAR IN SCHOOL LAW (3)** Research in substantive issues in school law. Prerequisite: Ed.Adm. 576.
595. **INTERNSHIP IN ADMINISTRATION AND SUPERVISION (1-15)** Guided experience in a school or other educational organization in which the student is not regularly employed, under supervision of a graduate faculty member. Prerequisites: Ed.Adm. 480, teaching experience, and a professional certificate.
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**

## EDUCATIONAL PSYCHOLOGY (EDPSY)

JOSEPH FRENCH, *In Charge of Graduate Programs in Educational Psychology*  
327 Cedar Building  
314-865-3427

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Francis J. Di Vesta, Ph.D. (Cornell) *Professor of Education and Psychology*  
Joseph L. French, Ed.D. (Nebraska) *Professor of Special Education and Educational Psychology*  
Paul A. Games, Ph.D. (Iowa) *Professor of Educational Psychology*  
Edmond Marks, Ph.D. (Penn State) *Senior Research Associate; Affiliate Associate Professor of Educational Psychology*  
Harold E. Mitzel, Ph.D. (Minnesota) *Professor of Psychology and Education*  
William Rabinowitz, Ph.D. (Columbia) *Professor of Educational Psychology*  
Dennis M. Roberts, Ed.D. (Florida State) *Associate Professor of Educational Psychology*  
Lita L. Schwartz, Ph.D. (Bryn Mawr) *Professor of Educational Psychology*  
Robert Seibel, Ph.D. (Iowa) *Associate Professor of Psychology and Educational Psychology*  
Paul D. Weener, Ph.D. (Michigan) *Associate Professor of Educational Psychology*

### Associate Member of the Graduate Faculty

Robert L. Hale, Ph.D. (Nebraska) *Assistant Professor of Education*

Graduate work is offered in the general field of educational psychology. Students may specialize and do research in one of the following areas: (1) human learning and memory as applied to instruction and education; (2) educational and psychological measurement; (3) statistics and research design as applied to education; and (4) the evaluation of educational programs. Special facilities available to students include rooms for conducting research projects and a closed-circuit television studio used for both research and instruction. Other facilities available to students majoring in Educational Psychology are the Nursery School, the Psychology Clinic, the Reading Center, the Center for Educational Diagnosis and Remediation, the Division of Instructional Services, and the Speech and Hearing Clinic. The Computation Center, with several computer systems, is available for use in graduate student research.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Students with a 3.00 junior-senior average and a broad undergraduate background, including some college mathematics, will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. Applicants are required to submit scores on the Graduate Record Examination. Applicants with a master's degree will be required to show more than minimum success in graduate study, including at least one-half of their graduate credits of A quality.

### Master's Degree Requirements

There are two options in the master's program. A thesis option is available in any of the four areas, and the M.S. without thesis may be taken in learning or evaluation by teachers, counselors, administrators, parents, and others concerned with intervention strategies or evaluation of educational programs. The M.S. with thesis is required for Ph.D. candidates. Other areas of study related to educational psychology, such as counseling and guidance, clinical psychology, school psychology, and special education, are offered in other departments of the University. The following courses, or their equivalents taken within the last five years, should be represented in the student's program prior to the evaluation for the M.S. degree and Ph.D. candidacy: Ed.Psy. 406, 421, 450, 475, and at least one 3-credit course in psychology from the biological bases of behavior, social bases of behavior, and individual differences.



**Doctoral Degree Requirements**

Doctoral degree requirements include a major emphasis in one of the four areas of educational psychology with minor emphasis in one other related area. The doctoral program of study includes those courses specified for a master's program and at least one course in educational or philosophical foundations. In lieu of the foreign language requirement for the Ph.D. degree, students are expected to present to the committee a statement of objectives and goals and a plan of the academic and nonacademic work to be undertaken in achieving these goals. Within the context of the above, the students are expected to incorporate relevant experiences which are now part of the language and communication requirements, whether in course work, research, or teaching, in order to increase their effectiveness as educational psychologists.

**Student Aids**

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following award typically has been available to graduate students in this program:

ALEXANDER PROUDFOOT FELLOWSHIP IN EDUCATIONAL PSYCHOLOGY — Available to a student with a strong interest in and aptitude for applying his or her skills in measurement to the problems of human performance in work situations; stipend \$3,600 plus tuition. Apply to Admissions Committee Chairman, Graduate Program in Educational Psychology, 327 Cedar Building.

**EDUCATIONAL PSYCHOLOGY (EDPSY)**

- 400. INTRODUCTION TO STATISTICS IN EDUCATIONAL RESEARCH (3)
- 406. APPLIED STATISTICAL INFERENCE FOR THE BEHAVIORAL SCIENCES (3)
- 420. (Spl.Ed. 420) THE MENTALLY GIFTED (3)
- 421. LEARNING PROCESSES IN RELATION TO EDUCATIONAL PRACTICES (3)
- 450. (Psy. 450) PRINCIPLES OF MEASUREMENT (3)
- 451. APPRAISAL AND INTERPRETATION OF STANDARDIZED GROUP TESTS (2)
- 460. PRINCIPLES OF PROGRAM EVALUATION (3)
- 475. INTRODUCTION TO EDUCATIONAL RESEARCH (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 506. ADVANCED TECHNIQUES FOR ANALYZING EDUCATIONAL EXPERIMENTS (3) Analytical and experimental control considerations for designs involving nested and/or crossed subjects. Analysis of variance and multiple comparison via computers. Prerequisite: Ed.Psy. 406 or Psy. 415.
- 507. MULTIVARIATE PROCEDURES IN EDUCATIONAL RESEARCH (3) Introduction to matrix algebra, computer programming, multiple regression analysis, multiple and canonical correlation, multiple discriminant analysis, classification procedures, factor analysis. Prerequisite: Ed.Psy. 406 or Psy. 415.
- 512. GROUP PROCESSES IN THE CLASSROOM (2) Basic concepts and perspectives in the study of group processes; instructional group interaction; analysis of classroom behavior.
- 513. INDIVIDUAL AND GROUP DIFFERENCES (3) Description, causes, and interpretation of individual variation over the life-span, with application to school and institutional practices. Prerequisite: Ed.Psy. 400 or 450.
- 519. PSYCHOLOGICAL FOUNDATIONS FOR COLLEGE TEACHING (3) Psychological, sociological, and organizational variables which influence instruction in colleges. For students planning teaching careers in colleges or similar settings.
- 523. CONCEPT LEARNING AND PROBLEM SOLVING (3-4) Theoretical-empirical trends in concept learning, problem solving, and creativity related to instructional psychology. Prerequisite: Ed.Psy. 421.
- 524. THEORIES OF LEARNING AND INSTRUCTION (3) Study of major classical theories of learning and recent developments in learning and instructional theory. Prerequisite: Ed.Psy. 421.
- 526. (RCLEd. 526) THE PSYCHOLOGY OF READING (3) Psychological principles underlying the process of reading and comprehending, with application to instruction. Prerequisite: Ed.Psy. 421.
- 527. PSYCHOLOGY OF ADULTS AS LEARNERS (3) Psychological principles related to learning by adults, with application to instruction and other educational practices. Prerequisite: Ed.Psy. 421.

## EDUCATIONAL THEORY AND POLICY

550. **DESIGN AND CONSTRUCTION OF PSYCHOLOGICAL MEASURES (3)** Lecture-practicum involving planning, construction, administration, and analysis of a psychological test; lectures stress construct validity, item analysis, and predictive validity. Prerequisite: Ed.Psy. 450.
554. **THEORIES OF PSYCHOLOGICAL MEASUREMENT (3)** Basic true-score and error models; their extensions to test reliability and test validity; problems of item analysis and weighting. Prerequisite: Ed.Psy. 450.
560. **CONTEMPORARY ISSUES IN THE EVALUATION OF EDUCATIONAL PROGRAMS (3)** Practical and theoretical issues in the planning, execution, and interpretation of program evaluations. Prerequisites: Ed.Psy. 450, 460.
575. **SEMINAR IN EDUCATIONAL PSYCHOLOGY (3-9)** A seminar dealing with specific topics in educational psychology. Open to advanced students in the behavioral sciences.
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**
602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)**

## EDUCATIONAL THEORY AND POLICY (EDTHP)

YOSHIMITSU TAKEI, *In Charge of Graduate Programs in Educational Theory and Policy*  
320 Rackley Building  
814-865-1488

**Degrees Conferred:** Ph.D., M.A.

### Senior Members of the Graduate Faculty

Joseph V. Alessandro, D.Ed. (Penn State) *Professor of Education*  
John Hardin Best, Ph.D. (North Carolina) *Professor of Education*  
Henry C. Johnson, Jr., Ph.D. (Illinois) *Professor of Education*  
Yoshimitsu Takei, Ph.D. (California) *Associate Professor of Education and Sociology*

### Associate Members of the Graduate Faculty

Francis R. McKenna, Ph.D. (Michigan) *Associate Professor of Education*  
Grayson Noley, Ph.D. (Penn State) *Assistant Professor of Education*  
Madhu S. Prakash, Ph.D. (Syracuse) *Assistant Professor of Education*

The master's and doctoral programs in Educational Theory and Policy are designed primarily to prepare persons for careers in education policy development and analysis. Students in the program may choose to emphasize policy development and analysis either in the United States or in terms of a comparative and international perspective. Individualized multidisciplinary programs of study in the foundation areas of education (history, philosophy, sociology, and comparative/international) and in the social sciences, management sciences, and/or humanities will be designed jointly by the student and the program faculty. Those who wish can qualify to receive certificates as international education development planning specialists or human resource development international planning specialists while engaged in their respective programs of study. It is anticipated that graduates will find employment in state departments of education, ministries of education, federal and international education agencies, academic institutions, and various professional associations.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Students with a 2.75 grade-point average will be considered for admission to the master's program, and with a 3.50 grade-point average at the master's level for the Ph.D. program. Excep-



tions to the minimum grade-point average may be made for students with special backgrounds, abilities, and interests.

### Master's Degree Requirements

Candidates who seek an M.A. in Educational Theory and Policy shall complete programs which will include studies in social theory, policy, and planning or in the social sciences or humanities. A thesis is required.

### Doctoral Degree Requirements

Candidates who seek a Ph.D. in Educational Theory and Policy shall complete programs which will include studies in social theory, policy, and planning, or in the social sciences or humanities.

All doctoral students must pass a written and oral candidacy examination after nine to eighteen hours of study.

Candidates for the Ph.D. degree are required to complete a minimum of two consecutive semesters (including summer sessions) in residence during an academic year.

The communication and foreign language requirements for the Ph.D. degree may be satisfied by options selected from foreign languages, statistics or mathematics, or computer science.

At the end of the program of study, each student must take a written comprehensive examination which will cover the student's major areas of study.

### Other Relevant Information

Upon admission, each student will be assigned to a faculty adviser whose specialization best coincides with the student's background or academic interest. For the master's degree, the adviser and student together will plan the program of study. For doctoral students, the adviser and student will plan the early aspects of study, but an interdisciplinary committee will be formed, soon after the student is admitted to candidacy, to supervise completion of a program of study.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## EDUCATIONAL THEORY AND POLICY (EDTHP)

401. INTRODUCTION TO COMPARATIVE EDUCATION (3)
402. GLOBAL EDUCATION (3)
403. EDUCATION IN SOCIALIST SOCIETIES (3)
404. EDUCATION IN AFRICA (3)
405. EDUCATION IN ASIA (3)
406. EDUCATION IN EUROPE (3)
407. EDUCATION IN LATIN AMERICA AND THE CARIBBEAN (3)
408. EDUCATION IN THE MIDDLE EAST (3)
411. ETHNIC MINORITIES AND SCHOOLS IN THE UNITED STATES (3)
412. EDUCATION AND THE STATUS OF WOMEN (3)
415. (Anth. 415) ANTHROPOLOGY OF EDUCATION (3)
416. (Soc. 416) SOCIOLOGY OF EDUCATION (3)
430. HISTORY OF EDUCATION IN THE UNITED STATES (2-3)
440. INTRODUCTION TO PHILOSOPHY OF EDUCATION (3)
441. EDUCATION, SCHOOLING, AND VALUES (3)
500. PROSEMINAR IN EDUCATIONAL THEORY AND POLICY (1) An introduction to disciplinary and interdisciplinary studies in educational theory and policy.
501. EDUCATION IN DEVELOPING COUNTRIES (3) The meaning of development and the role of education in the development process: theories, agents, trends, and case studies.
502. EDUCATIONAL PLANNING TECHNIQUES IN DEVELOPING COUNTRIES, PART I (3) The introduction of systematic analysis, methodologies, and analytical techniques of education programs and projects to aid decision making in educational planning.
503. EDUCATIONAL PLANNING TECHNIQUES IN DEVELOPING COUNTRIES, PART II (3) The application of systematic analysis to relevant educational planning cases that illustrate alternate solutions to particular problems of developing countries. Prerequisite: Ed.Th.P. 502.

## ELECTRICAL ENGINEERING

504. RURAL EDUCATION IN DEVELOPING NATIONS (3) Analysis of the rural societies, education, and change in the rural sector of developing nations.
505. NATIONALITY POLICY AND EDUCATION (3) Education and national integration; problems of cultural dominance in multinational states.
511. EDUCATION AND POLITICAL SOCIALIZATION (3) An examination of the studies which examine the function of schools in socializing the young for adult political roles.
512. EDUCATION AND THE SOCIAL STRUCTURE (3) An examination of the relationships between educational opportunities and social structure.
514. SOCIAL CHANGE, CULTURAL DYNAMICS, AND EDUCATION (3) The role of the school in promoting either social change or stability.
518. ANALYSIS OF U.S. EDUCATIONAL POLICY (3) The interaction between educational theory and social structure, focusing on the role of practicing intellectuals in contemporary institutional settings.
530. DEVELOPMENT OF THE AMERICAN SCHOOL (3) American schooling critically examined institutionally from an historical perspective in social-cultural context. Emphasis on theories of interpretation and change.
531. STUDIES IN WESTERN EDUCATIONAL THOUGHT TO 1500 (3) General review and critical examination of selected Western educational ideas and movements from pre-Classical, Classical, Medieval, and early Renaissance periods.
533. SOCIAL HISTORY AND EDUCATION POLICY (3) Historical study of social dimensions in the formation of education policy.
536. STUDIES IN EDUCATIONAL THOUGHT (3) Studies in the historical development of educational theory.
537. HISTORY OF AMERICAN INDIAN EDUCATION POLICY (3) Focusing on the relationship between American Indians and the United States, this course examines historical and contemporary federal education policy.
540. DEWEY AND THE PRAGMATIC-INSTRUMENTALIST EDUCATIONAL TRADITION (3) Critical examination of John Dewey's educational thought in the context of pragmatic philosophy and progressivism in American education.
541. CONTEMPORARY PHILOSOPHIES OF EDUCATION (3) Educational theory and practice in relation to contemporary movements in philosophy.
550. SEMINAR IN AMERICAN INDIAN EDUCATION (1-9) Analysis of issues of contemporary interest in American Indian education.
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

## ELECTRICAL ENGINEERING (E E)

DALE M. GRIMES, *Head of the Department*  
129 Electrical Engineering East  
814-865-7667

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

William S. Adams, Ph.D. (Penn State) *Professor of Electrical Engineering*  
John L. Brown, Jr., Ph.D. (Brown) *Professor of Electrical Engineering*  
Lynn A. Carpenter, Ph.D. (Illinois) *Professor of Electrical Engineering*  
Leslie E. Cross, Ph.D. (Leeds) *Professor of Electrical Engineering*  
Mukunda B. Das, Ph.D. (London), D.I.C. *Professor of Electrical Engineering*  
George A. Etzweiler, Ph.D. (Penn State) *Associate Professor of Electrical Engineering*  
Anthony J. Ferraro, Ph.D. (Penn State) *Professor of Electrical Engineering*  
David B. Geselowitz, Ph.D. (Pennsylvania) *Professor of Bioengineering*  
Dale M. Grimes, Ph.D. (Michigan) *Professor of Electrical Engineering*  
Leslie C. Hale, Ph.D. (Carnegie Tech.) *Professor of Electrical Engineering*



Gerard Lachs, Ph.D. (Syracuse) *Professor of Electrical Engineering*  
 Hai-Sup Lee, Ph.D. (Penn State) *Professor of Electrical Engineering*  
 John B. Lewis, Ph.D. (Purdue) *Professor of Electrical Engineering*  
 George J. McMurtry, Ph.D. (Purdue) *Professor of Electrical Engineering*  
 John S. Nisbet, Ph.D. (Penn State) *Professor of Electrical Engineering*  
 James W. Robinson, Ph.D. (Michigan) *Professor of Electrical Engineering*  
 William J. Ross, Ph.D. (New Zealand) *Professor of Electrical Engineering*  
 Joseph Stach, Ph.D. (Penn State) *Professor of Electrical Engineering*  
 Frederick C. Trutt, Ph.D. (Delaware) *Professor of Electrical Engineering*  
 Francis T. S. Yu, Ph.D. (Michigan) *Professor of Electrical Engineering*

#### **Associate Members of the Graduate Faculty**

Lee D. Coraor, Ph.D. (Iowa) *Assistant Professor of Electrical Engineering*  
 James F. Delansky, Ph.D. (Cornell) *Associate Professor of Electrical Engineering*  
 Steven J. Fonash, Ph.D. (Pennsylvania) *Professor of Engineering Science*  
 Jay R. Herman, Ph.D. (Penn State) *Adjunct Senior Research Associate*  
 Paul T. Hulina, Ph.D. (Penn State) *Associate Professor of Electrical Engineering*  
 Donald E. Kerr, Ph.D. (Penn State) *Senior Research Associate*  
 John D. Mathews, Ph.D. (Case Western Reserve) *Adjunct Assistant Professor of Electrical Engineering*  
 John A. Mitchell, Ph.D. (Penn State) *Associate Professor of Electrical Engineering*  
 Richard A. Mollo, Ph.D. (Penn State) *Assistant Professor of Electrical Engineering*  
 Joseph R. Monkowski, Ph.D. (Penn State) *Associate Professor of Electrical Engineering*  
 Leonid M. Roytman, Ph.D. (Polytech. Inst., USSR) *Associate Professor of Electrical Engineering*  
 Jack J. Stein, Dr.Eng.Sci. (New York) *Associate Professor of Electrical Engineering*  
 Frank W. Symons, Ph.D. (Penn State) *Research Associate*  
 Ken Tomiyama, Ph.D. (U.C.L.A.) *Assistant Professor of Electrical Engineering*

The principal areas of graduate research are in ionospheric studies, solid state electronics, computers and digital systems, power systems, electromagnetics, electro-optics, communications, and automatic control. Course offerings support these research areas, as well as work in biomedical engineering, network and system theory, plasmas, and quantum electronics.

For information about areas of specialization, laboratory and research facilities, fellowships, assistantships, and other sources of financial assistance, write directly to the Department of Electrical Engineering, The Pennsylvania State University, University Park, PA 16802.

#### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

**Admission to the M.S. Program:** (1) Satisfactory completion of an undergraduate electrical engineering program at an accredited institution or the equivalent, or (2) satisfactory completion of an undergraduate physics program at The Pennsylvania State University or an equivalent institution, with a minor in electronics. Such applicants will take two undergraduate courses in addition to the specific course requirements listed below. There are also some restrictions on their electives.

**Admission to the Doctoral Program:** (1) Satisfactory completion of the M.S. degree requirements in electrical engineering or a closely related field at The Pennsylvania State University or an equivalent institution, or (2) direct admission from the undergraduate program for highly qualified individuals.

#### **Master's Degree Requirements**

The Master of Science requirements include the general requirements of the Graduate School as listed under Master's Degree Requirements.

**Specific Course Requirements:** (1) Thesis option — 24 course credits, 6 thesis credits, and a satisfactory thesis; (2) Nonthesis option — 30 course credits, a scholarly report, and a special M.S. examination which is the same as the Ph.D. candidacy examination. For either option, 6 credits must be taken outside the department.

#### **Doctoral Degree Requirements**

The Doctor of Philosophy requirements include the general requirements of the Graduate School as listed under Doctoral Degree Requirements.

## ELECTRICAL ENGINEERING

**Specific Requirements:** The communication requirement is met by adequacy in the English language and computer programming. The candidacy examination consists of both written and oral parts, and the comprehensive examination is oral.

### Other Relevant Information

Students in this program may elect the dual-title degree program option in Operations Research for the Ph.D. and M.S. degrees (see p. 285).

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

**W. S. ELLIOTT FELLOWSHIP** — Available to a graduate student who is a graduate of The Pennsylvania State University and is interested in engineering research; stipend variable. Apply to Office of the Dean, College of Engineering, 101 Hammond Building.

**G. T. E. FELLOWSHIPS** — Available to a graduate student in electrical engineering. U.S. citizenship is required. Stipend is \$11,000 for twelve months.

**HARRIS CORPORATION FELLOWSHIP** — Available to a graduate student in electrical engineering. Stipend is \$9,000 for twelve months.

**PALMER FELLOWSHIP SUPPLEMENT** — Accrued interest supplements the stipend of a graduate assistant.

**RCA CORPORATION FELLOWSHIP** — Available to a graduate student in electrical engineering. Stipend is \$4,000 for nine months. May be supplemented for an additional three months on application.

**SCHLUMBERGER AWARD** — The outstanding teaching assistant receives an award of \$500.

**TAU BETA PI FELLOWSHIP** — Open to any member of Tau Beta Pi, the engineering honor society, for a year of advanced study. Up to eighteen awards of \$3,500 each are available. Applications and information may be obtained from the Office of the Dean, College of Engineering, 101 Hammond Building. Application deadline is February 15.

## ELECTRICAL ENGINEERING (E E)

- 405. ELECTRONIC INSTRUMENTATION FOR NONELECTRICAL ENGINEERS AND SCIENTISTS (3)
- 406. ELECTRICAL POWER GENERATION AND TRANSMISSION (3)
- 411. PRINCIPLES OF ELECTROMAGNETIC FIELDS (3)
- 413. LINEAR NETWORK ANALYSIS (3)
- 414. PRINCIPLES AND APPLICATIONS OF LASERS AND MASERS (3)
- 415. (Cmp.Sc. 415) COMPUTER SYSTEMS ARCHITECTURE (3)
- 417. SYSTEM THEORY (3)
- 418. SOLID STATE DEVICE TECHNOLOGY (3)
- 419. SOLID STATE DEVICES (3)
- 420. ELECTRO OPTICS — INTRODUCTION TO HOLOGRAPHY (3)
- 423. FUNDAMENTALS OF INDUSTRIAL ELECTRONICS (3)
- 424. FUNDAMENTALS OF ELECTRICAL DESIGN (3)
- 425. SYMMETRICAL COMPONENTS (3)
- 427. DISCRETE-TIME SYSTEMS (3)
- 428. LINEAR CONTROL SYSTEMS (3)
- 432. UHF AND MICROWAVE ENGINEERING (3)
- 438. ANTENNA ENGINEERING (3)
- 447. DIGITAL INTEGRATED CIRCUITS (3)
- 448. LINEAR ELECTRONIC DESIGN (3)
- 449. DIGITAL ELECTRONIC DESIGN (3)
- 450. NETWORK ANALYSIS (3)
- 458. DATA COMMUNICATION (3)
- 459. INTRODUCTION TO STATISTICAL THEORY OF COMMUNICATIONS (3)
- 461. FUNDAMENTALS OF POWER SYSTEM STABILITY (3)
- 470. ELECTRONIC ANALOG COMPUTERS (3)
- 472. DIGITAL SYSTEMS (3)



- 473. DIGITAL SYSTEMS LABORATORY (3)
- 475. INTRODUCTION TO HYBRID COMPUTATION (3)
- 477. SYNTHESIS AND DESIGN OF ELECTRICAL SYSTEMS (3)
- 490. (Nuc.E. 490) INTRODUCTION TO PLASMAS (3)
- 492. (Astro. 492) SPACE ASTRONOMY AND INTRODUCTION TO SPACE SCIENCE (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 519. SEMICONDUCTOR DEVICES (3) Characteristics and limitations of bipolar transistors, diodes, transit time, and bulk-effect devices. Prerequisite: E.E. 419.
- 520. ELECTRO OPTICS — OPTICAL INFORMATION PROCESSING (3) Coherent and incoherent optical information processing, synthetic aperture radar, complex spatial filtering, image synthesis, color image processing, applications. Prerequisite: E.E. 420.
- 527. LINEAR CONTROL SYSTEMS (3) Continuous and discrete-time linear control systems; state variable models; analytical design for deterministic and random inputs; time-varying systems stability. Prerequisites: E.E. 428 or M.E. 455; E.E. 417.
- 528. NONLINEAR CONTROL AND STABILITY (3) Design of nonlinear automatic control systems; phase-plane methods; describing functions; optimum switched systems; Liapunov stability; special topics in stability. Prerequisites: E.E. 428 or M.E. 455; E.E. 417.
- 529. OPTIMAL CONTROL (3) Variational methods in control system design; classical calculus of variations, dynamic programming, maximum principle; optimal digital control systems; state estimation. Prerequisite: E.E. 527.
- 530. ADAPTIVE AND LEARNING SYSTEMS (3) Adaptive and learning control systems; system identification; performance indices; gradient, stochastic approximation, controlled random search methods; introduction to pattern recognition. Prerequisite: E.E. 527.
- 535. ENGINEERING ANALYSIS (3) Applications of mapping methods, series and integral representations to the solution of boundary-value problems in electrical engineering.
- 538. ANTENNA ENGINEERING (3) In-depth studies of synthesis methods, aperture sources, broadband antennas, and signal-processing arrays. Prerequisite: E.E. 438.
- 540. (Nuc.E. 540) THEORY OF PLASMA WAVES (3) Solutions of the Boltzmann equation; waves in bounded and unbounded plasmas; radiation and scattering from plasmas. Prerequisite: E.E. (Nuc.E.) 490.
- 541. (Nuc.E. 541) PLASMA THEORY (3) Advanced topics in kinetic theory, fluctuation theory, microinstability, and turbulence. Prerequisite: E.E. (Nuc.E.) 490.
- 546. FIELD-EFFECT DEVICES (3) The physical background, characteristics, and limitations of surface field-effect and junction field-effect devices and related structures. Prerequisite: E.E. 419.
- 547. DIELECTRIC DEVICES (3) Applications of insulator physics and devices based on insulator properties. Prerequisite: E.E. 419.
- 548. LINEAR INTEGRATED CIRCUITS (3) Design of monolithic, thin-film, and hybrid linear integrated circuits; D.C., video, tuned, r.f., and microwave applications. Emphasis on reliability. Prerequisites: E.E. 418, 448.
- 550. NETWORK SYNTHESIS (3) Positive real functions, realizability conditions, synthesis of driving point immittances, synthesis of two-terminal pair networks, transfer function synthesis. Prerequisite: E.E. 450.
- 560. STATISTICAL THEORY OF COMMUNICATIONS (3) Generalized harmonic analysis; the application of correlation and convolution to the detection of signals in noise; various special topics. Prerequisite: E.E. 459 or Math. (Stat.) 409.
- 561. INFORMATION THEORY (3) Mathematical measurement of information; information transfer in discrete systems; redundancy, efficiency, and channel capacity; encoding systems. Prerequisite: E.E. 459 or Math. (Stat.) 409.
- 562. DETECTION THEORY (3) Detection decision theory, Bayes and Neyman-Pearson criteria, optimal receivers, classical estimation theory, signal-noise representations, optimum linear signal parameters estimation. Prerequisite: E.E. 560.

## ENGINEERING MECHANICS

565. **COMPUTER ANALYSIS OF POWER SYSTEMS (3)** Network matrix methods of power system analysis. Formulation and computer solution of short circuit, load flow, and transient stability problems. Prerequisites: Cmp.Sc. 201; E.E. 425 or 461.

569. **SIMULATION OF BIOMEDICAL SYSTEMS (3)** Simulation of biological and medical systems on analog and digital computers; direct electrical analogs; modeling techniques. Prerequisites: E.E. 470, Biol. 101.

570. **ADVANCED ELECTRONIC ANALOG COMPUTERS (3)** Advanced techniques of analog computation and simulation; machine and problem errors; nonlinear differential equations. Prerequisite: E.E. 470.

571. **SWITCHING AND SEQUENTIAL MACHINE THEORY (4)** Advanced treatment of switching and machine theory, minimization of machines, state assignment, hazard analysis. Prerequisite: E.E. 472.

572. **DIGITAL SYSTEM DESIGN (3)** Complete digital system design, including specification, internal organization, and realization. Discussion of interaction among digital systems and subsystems. Prerequisite: E.E. 472.

573. **FAULT DETECTION IN DIGITAL CIRCUITS (3)** Advanced treatment of fault detection, location, and redundancy techniques. Prerequisite: E.E. 472.

580. **RADIO WAVES AND THE IONOSPHERE (3)** The magneto-ionic theory of ionospheric wave propagation; ray-optical approximations; determination of ionization profiles; full wave solutions; nonlinear and coupling effects. Prerequisite: E.E. 438 or Phys. 557.

581. **CONSTITUTION OF THE IONOSPHERE (3)** Properties of neutral and ionized atmosphere above 60 km; photochemical processes; solar, meteoric perturbations of the ionosphere; large-scale movements in ionization.

596. **INDIVIDUAL STUDIES (1-9)**

597. **SPECIAL TOPICS (1-9)**

## ENGINEERING MECHANICS (E MCH)

R. P. McNITT, *Head of the Department of Engineering Science and Mechanics*  
227B Hammond Building  
814-865-6661

**Degrees Conferred:** Ph.D., M.S., M.Eng.

### Senior Members of the Graduate Faculty

S. Ashok, Ph.D. (Rensselaer) *Assistant Professor of Engineering Mechanics*  
J. C. Conway, Ph.D. (Penn State) *Professor of Engineering Mechanics*  
Stephen J. Fonash, Ph.D. (Pennsylvania) *Professor of Engineering Science*  
S. I. Hayek, Dr.Eng.Sci. (Columbia) *Professor of Engineering Mechanics*  
L. W. Hu, Ph.D. (Penn State) *Professor of Engineering Mechanics*  
J. Kiusalaas, Ph.D. (Northwestern) *Professor of Engineering Mechanics*  
R. E. Llorens, Ph.D. (Penn State) *Professor of Engineering Mechanics*  
R. P. McNitt, Ph.D. (Purdue) *Professor of Engineering Science and Mechanics*  
V. H. Neubert, D.Eng. (Yale) *Professor of Engineering Mechanics*  
R. A. Queeney, Ph.D. (Penn State) *Professor of Engineering Mechanics*  
M. G. Sharma, Ph.D. (Penn State) *Professor of Engineering Mechanics*  
William Thompson, Jr., Ph.D. (Penn State) *Associate Professor of Engineering Science*  
S. Y. Zamrik, Ph.D. (Penn State) *Professor of Engineering Mechanics*

### Associate Members of the Graduate Faculty

R. N. Pangborn, Ph.D. (Rutgers) *Assistant Professor of Engineering Mechanics*  
Andrew Pytel, Ph.D. (Penn State) *Associate Professor of Engineering Mechanics*  
D. L. Questad, Ph.D. (Rutgers) *Assistant Professor of Engineering Mechanics*

Graduate programs in Engineering Mechanics emphasize fundamental knowledge and include research opportunities in theoretical and experimental mechanics, with a primary focus on the mechanics and physics of solids.



Graduate study is available in continuum mechanics, structural mechanics, dynamics, vibrations and acoustics, biomechanics, micromechanics, experimental mechanics, and characterization and utilization of materials. Thesis work in these areas is frequently directed toward specific applications of technological interest in biosystems, geosystems, energy production and distribution, materials engineering, and structural design.

#### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in the program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

The entering student must hold a bachelor's degree in engineering or science and have satisfactorily completed undergraduate courses in mechanics. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

#### Doctoral Degree Requirements

The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of one foreign language.

Programs leading to a minor in Engineering Mechanics are available for doctoral students who seek to complement their studies in their major fields by acquiring a broader background in theoretical and experimental mechanics.

#### Other Relevant Information

Other course offerings of the department are listed under OTHER COURSES AND OPTIONS CARRYING GRADUATE CREDIT.

#### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

**W. S. ELLIOTT FELLOWSHIP** — Available to a graduate student who is a graduate of The Pennsylvania State University and is interested in engineering research; stipend variable. Apply to Office of the Dean, College of Engineering, 101 Hammond Building.

**TAU BETA PI FELLOWSHIP** — Open to any member of Tau Beta Pi, the engineering honor society, for a year of advanced study. Up to eighteen awards of \$3,500 each are available. Applications and information may be obtained from the Office of the Dean, College of Engineering, 101 Hammond Building. Application deadline is February 15.

#### ENGINEERING MECHANICS (E MCH)

- 400. ADVANCED STRENGTH OF MATERIALS AND DESIGN (3) *Hu*
- 401. DESIGN AND SYNTHESIS IN VIBRATIONS (3)
- 402. APPLIED AND EXPERIMENTAL STRESS ANALYSIS (3) *Conway*
- 403. STRENGTH DESIGN IN MATERIALS AND STRUCTURES (4) *Queeney*
- 407. COMPUTER METHODS IN ENGINEERING DESIGN (3) *Kiusalaas*
- 408. ELASTICITY AND ENGINEERING APPLICATIONS (3) *Kiusalaas*
- 409. ADVANCED MECHANICS (3)
- 410. MECHANICS OF SPACE FLIGHT (3)
- 412. EXPERIMENTAL METHODS IN VIBRATIONS (3) *Neubert*
- 415. FRACTURE MECHANICS (3) *Queeney*
- 416. FAILURE AND FAILURE ANALYSIS OF SOLIDS (3)
- 446. MECHANICS OF VISCOELASTIC MATERIALS (3) *Sharma*
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

500. ADVANCED MECHANICS OF MATERIALS (3-6) Strain energy methods; special problems in bending and torsion; curved bars, beams on elastic foundations; thick-walled cylinders, shrink-fit assemblies, and rotating discs; thin-walled pressure vessels; bending of thin plates; buckling of bars and plates. Prerequisite: E.Mch. 13. *Zamrik*
506. EXPERIMENTAL STRESS ANALYSIS (3) Experimental methods of stress determination, including photoelasticity, stress coat, and electric strain gauge techniques; stress analogies; strain rosettes for combined stress determinations. Prerequisite: E.Mch. 408 or 507. *Conway*
507. THEORY OF ELASTICITY AND APPLICATIONS (3) Equations of equilibrium and compatibility; stresses and strains in beams, curved members, rotating discs, thick cylinders, torsion and structural members. Prerequisite: E.Mch. 13.
509. THEORY OF PLATES AND SHELLS (3) Bending and buckling of plates; elastic foundations; deformation of shells, multilayer shells, stress and stability analysis, weight optimization, application problems. Prerequisite: E.Mch. 13.
514. ENGINEERING MECHANICS SEMINAR (1 per semester) Current literature and special problems in engineering mechanics.
516. MATHEMATICAL THEORY OF ELASTICITY (3) Fundamental equations and problems of elasticity theory; uniqueness theorems and variational principles; methods of stress functions and displacement potential; applications. Prerequisite: E.Mch. 540. *Hayek*
520. ADVANCED DYNAMICS (3) Dynamics of a particle and of rigid bodies; Newtonian equations in moving coordinate systems; Lagrange's and Hamilton's equations of motion; special problems in vibrations and dynamics. Prerequisites: E.Mch. 12, Math. 250. *Pytel*
521. STRESS WAVES IN SOLIDS (3) Theoretical fundamentals, classic experiments; recent advances, including scabbing applications, plastic waves, penetration mechanics, impact and numerical methods. Prerequisites: E.Mch. 12; Math. 411 or E.Mch. 524A and 524B.
522. THEORY OF VIBRATIONS (3) Mathematical theory of vibrating systems; damping phenomena; forced vibrations; analogy between mechanical and electrical vibrations; transverse and torsional oscillation of shafts; vibration of strings, beams, membranes, and plates. Prerequisites: E.Mch. 13, Math. 250. *Neubert*
524. MATHEMATICAL METHODS IN ENGINEERING (3 per unit) *Hayek and Thompson*  
*Unit A* (3) Application of special functions, orthogonal series, and boundary-value problems to problems in mechanics and other engineering fields. Prerequisite: Math. 250.  
*Unit B* (3) Solution techniques for boundary-value problems in curvilinear coordinates, integral transforms; Green's functions, potentials, application to diffusion, vibration, wave propagation. Prerequisite: E.Mch. 524A or E.Sc. 404H.
525. VIBRATION AND SHOCK IN DAMPED MECHANICAL SYSTEMS (3) Rubberlike materials; vibration isolation; structural impedance; wave propagation; multiforce excitation of beams; Timoshenko beams; transients; shock spectra; damage; nonlinear response. Prerequisite: E.Mch. 401 or 522.
527. STRUCTURAL DYNAMICS (3) Dynamic behavior of structural systems; normal modes; input spectra; finite element representation of frameworks, plates, and shells; impedance; elastic-plastic response. Prerequisites: E.Mch. 12, 13. *Neubert*
528. EXPERIMENTAL METHODS IN VIBRATIONS (3) Investigation of one or more degrees of freedom, free and forced mechanical vibrations, vibration properties of materials, nondestructive testing. Prerequisite: E.Mch. 401 or 522. *Neubert*
530. SOLID STATE MECHANICS (3) Relation between solid state physics and mechanics; mechanical properties for static, fatigue, creep, and impact conditions; high-temperature properties; applications. *Hu*
531. THEORY OF PLASTICITY AND APPLICATIONS (3) Yield condition; plastic stress-strain relations; theory of slip-line fields; applications to bending, torsion, axially symmetric bodies, metal processing. Prerequisite: E.Mch. 507. *Hu*
532. FRACTURE MECHANICS (3) Stress analysis of cracks; stable and unstable crack growth in structures and materials; materials fracture resistance. Prerequisite: E.Mch. 500.



535. (Metal. 535) CRYSTAL DEFECTS AND MECHANICAL RESPONSE (3) Mechanical responses of crystalline solids containing point, line, and interfacial defects; elastic and plastic responses. Prerequisite: Metal. 514 or E.Sc. 414H. *Queeney*

540. INTRODUCTION TO CONTINUUM MECHANICS (3) Algebra and analysis of tensors; balance equations of classical physics; the linear theories of continuum mechanics. *Hayek*

546. THEORY OF VISCOELASTICITY AND APPLICATIONS (3) Linear and nonlinear viscoelastic theories; generalized isotropic and anisotropic viscoelastic stress-strain relations. Prerequisite: E.Mch. 507. *Sharma*

550. VARIATIONAL AND ENERGY METHODS IN ENGINEERING (3) Application of variational calculus and Hamilton's principle to various conservative and nonconservative systems; closed form and approximate technique. Prerequisite: Math. 351.

560. FINITE ELEMENT ANALYSIS (3) General theory; application to statics and dynamics of solids, structures, fluids, and heat flow; use of existing computer codes. Prerequisites: Cmp.Sc. 201, E.Mch. 13.

570. RANDOM VIBRATIONS IN STRUCTURAL MECHANICS (3) Probability theory applied to random vibrations of linear and nonlinear systems; excitation by ground motion, turbulence, and noise; acoustic damping. Prerequisite: Aersp. 411 or E.Mch. 401 or 522. *Neubert*

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

## ENGINEERING SCIENCE (E SC)

R. P. McNITT, *Head of the Department of Engineering Science and Mechanics*  
227B Hammond Building  
814-865-6661

**Degree Conferred:** M.S.

### Senior Members of the Graduate Faculty

S. Ashok, Ph.D. (Rensselaer) *Assistant Professor of Engineering Mechanics*  
J. C. Conway, Ph.D. (Penn State) *Professor of Engineering Mechanics*  
Stephen J. Fonash, Ph.D. (Pennsylvania) *Professor of Engineering Science*  
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J. Kiusalaas, Ph.D. (Northwestern) *Professor of Engineering Mechanics*  
R. E. Llorens, Ph.D. (Penn State) *Professor of Engineering Mechanics*  
R. P. McNitt, Ph.D. (Purdue) *Professor of Engineering Science and Mechanics*  
V. H. Neubert, D.Eng. (Yale) *Professor of Engineering Mechanics*  
R. A. Queeney, Ph.D. (Penn State) *Professor of Engineering Mechanics*  
M. G. Sharma, Ph.D. (Penn State) *Professor of Engineering Mechanics*  
William Thompson, Jr., Ph.D. (Penn State) *Associate Professor of Engineering Science*  
S. Y. Zamrik, Ph.D. (Penn State) *Professor of Engineering Mechanics*

### Associate Members of the Graduate Faculty

R. N. Pangborn, Ph.D. (Rutgers) *Assistant Professor of Engineering Mechanics*  
Andrew Pytel, Ph.D. (Penn State) *Associate Professor of Engineering Mechanics*  
D. L. Questad, Ph.D. (Rutgers) *Assistant Professor of Engineering Mechanics*

This program is characterized by strong components in engineering analysis, the basic sciences, and areas of emerging technological importance. The program is interdisciplinary in structure with sufficient flexibility to allow a student to specialize in any of a variety of disciplines according to his or her professional objectives.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the*

## ENGINEERING SCIENCE

*APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Admission to the program requires a bachelor's degree in engineering or science from an accredited institution, with a junior-senior grade-point average of at least 2.50. The best-qualified applicants will be accepted up to the number of spaces that are available for new students.

### Degree Requirements

The basic requirements of course work by subject area are as follows:

Engineering Analysis	— 6 credits
Materials	— 6 credits
Basic Sciences	— 6 credits
Engineering Sciences	— 6 credits

Within these guidelines, work in the listed areas may be arranged in consultation with the adviser to constitute a program of study to accommodate the objectives of the student, and it is expected that courses outside the department may constitute part of the content in the engineering sciences.

A thesis is required for the M.S. degree as part of the 30 credits required in the program.

### Other Relevant Information

This program should be distinguished from the graduate program in Engineering Science at Behrend, Capitol, and King of Prussia which offers the M.Eng. degree.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

W. S. ELLIOTT FELLOWSHIP — Available to a graduate student who is a graduate of The Pennsylvania State University and is interested in engineering research; stipend variable. Apply to Office of the Dean, College of Engineering, 101 Hammond Building.

TAU BETA PI FELLOWSHIP — Open to any member of Tau Beta Pi, the engineering honor society, for a year of advanced study. Up to eighteen awards of \$3,500 each are available. Applications and information may be obtained from the Office of the Dean, College of Engineering, 101 Hammond Building. Application deadline is February 15.

## ENGINEERING SCIENCE (E SC)

- 400H. ELECTROMAGNETIC FIELDS (3)
- 401H. SENIOR DESIGN PROJECT (2)
- 402H. SENIOR DESIGN PROJECT (2)
- 403H. SENIOR DESIGN PROJECT (3)
- 404H. ANALYSIS IN ENGINEERING SCIENCE (3)
- 405. ENGINEERING APPLICATIONS OF FIELD THEORY (3)
- 406H. ANALYSIS IN ENGINEERING SCIENCE II, HONORS (3)
- 407H. COMPUTER METHODS IN ENGINEERING SCIENCE, HONORS (3)
- 410H. SENIOR DESIGN PROJECT, HONORS (3)
- 411H. SENIOR DESIGN PROJECT, HONORS (4)
- 414H. ELEMENTS OF MATERIAL SCIENCE (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

501. SOLID STATE ENERGY CONVERSION (3) Principles of solid state energy conversion and their utilization in engineering devices. Emphasis on current research and development efforts. Prerequisite: E.E. 419 or Phys. 412.

502. SEMICONDUCTOR HETEROJUNCTIONS AND APPLICATIONS (3) Theory, fabrication techniques, and electronic applications of semiconductor heterojunctions, including metal-semiconductor and electrolyte-semiconductor junctions. Prerequisite: E.Sc. 314 or 414.

511. ENGINEERING MATERIALS FOR ENERGY CONVERSION AND STORAGE (3) This course treats engineering materials and systems employed in conventional and unconventional direct energy conversion and energy storage.



## 596. INDIVIDUAL STUDIES (1-9)

## 597. SPECIAL TOPICS (1-9)

NOTE: *Other departmental courses are listed under Engineering Mechanics.*

**ENGINEERING SCIENCE (E SC)**

GEORGE J. McMURTRY, *Associate Dean for Instruction, College of Engineering*  
101 Hammond Building  
(814) 865-2151

BEHREND COLLEGE — Anthony A. Salvia, *Director of Program*

KING OF PRUSSIA CENTER FOR GRADUATE STUDIES — Helmut E. Weber, *Director of Program*

CAPITOL CAMPUS — Lawrence A. Ezard, *Director of Program*

**Degree Conferred:** M.Eng.

## BEHREND

**Associate Members of the Graduate Faculty**

Richard A. Bollinger, Ph.D. (Pittsburgh) *Associate Professor of Mathematics*

Anthony A. Salvia, Ph.D. (Case Western Reserve) *Associate Professor of Industrial Engineering*

## KING OF PRUSSIA

**Senior Members of the Graduate Faculty**

Richard E. Llorens, Ph.D. (Penn State) *Professor of Engineering Mechanics*

Helmut E. Weber, Sc.D. (M.I.T.) *Professor of Mechanical Engineering*

**Associate Members of the Graduate Faculty**

Robert L. Duncan, M.A. (Penn State) *Associate Professor of Mathematics*

Eugene Kozik, Ph.D. (Pittsburgh) *Associate Professor of Industrial Engineering*

Jack Stein, Ph.D. (N.Y.U.) *Associate Professor of Electrical Engineering*

## CAPITOL CAMPUS

**Senior Members of the Graduate Faculty**

Barnard H. Bissinger, Ph.D. (Cornell) *Professor of Mathematics*

Charles A. Cole, Ph.D. (Rutgers) *Professor of Engineering*

Sabir H. M. Dahir, Ph.D. (North Carolina State) *Professor of Engineering*

George H. Grenier, Ph.D. (Montana) *Professor of Engineering*

Vedula N. Murty, Ph.D. (Purdue) *Professor of Mathematics*

**Associate Members of the Graduate Faculty**

Lawrence A. Ezard, Ph.D. (Pennsylvania) *Associate Professor of Engineering*

Jefferson S. Hartzler, Ph.D. (Penn State) *Associate Professor of Mathematics*

William R. Miller, Ph.D. (Delaware) *Associate Professor of Engineering*

Jerome J. Przybylski, Ph.D. (Western Michigan) *Assistant Professor of Mathematics*

Roger W. Schiller, M.S. (Kansas) *Associate Professor of Engineering*

Jerry F. Shoup, Ph.D. (Penn State) *Associate Professor of Engineering*

John S. Wade, Jr., Ph.D. (Tennessee) *Associate Professor of Engineering*

Clifford H. Wagner, Ph.D. (S.U.N.Y., Albany) *Assistant Professor of Mathematics*

William A. Welsh, Ph.D. (Illinois) *Associate Professor of Engineering*

A program leading to the degree of Master of Engineering with a major in Engineering Science is offered at The Behrend College, the King of Prussia Center for Graduate Studies, and The Capitol Campus. The program is designed to provide a broad, advanced education in the engineering sciences with some specialization permitted in the area of the student's major interest. It is offered specifically to permit practicing engineers to pursue advanced studies through evening classes while in full-time employment in industry in the area. Courses offered for the program are all established and authorized by the resident departments at the University Park Campus.

This program should be distinguished from the graduate program in Engineering Science at University Park which offers the M.S. degree.

### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Students may be admitted to the program from a wide variety of disciplines. Students applying for admission are expected to have completed the following core courses: (1) physics through modern physics; (2) mathematics through differential equations; (3) one course in engineering thermodynamics; (4) one course in electrical circuits; and (5) basic courses in engineering statics and dynamics. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

### **Degree Requirements**

The credit requirements in this major will be satisfied by an appropriate combination of core courses and elective courses. The core courses include offerings in mathematics and in several branches of engineering which have been selected because of their general character and breadth of applicability to all fields of engineering.

A minimum of 30 credits is required, of which at least 12 must be at the 500 level. A scholarly written report is also required. Three of the above credits may be applied to this report.

### **Other Relevant Information**

Further details regarding admission requirements are available from the directors of the graduate centers offering the program.

### **Student Aids**

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

**W. S. ELLIOTT FELLOWSHIP** — Available to a graduate student who is a graduate of The Pennsylvania State University and is interested in engineering research; stipend variable. Apply to Office of the Dean, College of Engineering, 101 Hammond Building.

**TAU BETA PI FELLOWSHIP** — Open to any member of Tau Beta Pi, the engineering honor society, for a year of advanced study. Up to eighteen awards of \$3,500 each are available. Applications and information may be obtained from the Office of the Dean, College of Engineering, 101 Hammond Building. Application deadline is February 15.

## **ENGLISH (ENGL)**

ROBERT A. SECOR, *Director of Graduate Studies*  
120 Burrowes Building  
814-863-2629

**Degrees Conferred:** Ph.D., M.A., M.Ed.

### **Senior Members of the Graduate Faculty**

Judd B. Arnold, Ph.D. (Connecticut) *Associate Professor of English*  
Deborah S. Austin, Ph.D. (Bryn Mawr) *Professor of English*  
John Balaban, M.A. (Harvard) *Professor of English*  
Michael H. Begnal, Ph.D. (Washington) *Professor of English and Comparative Literature*  
Elmer W. Borklund, Ph.D. (Chicago) *Professor of English*  
John K. Crane, Ph.D. (Penn State) *Associate Professor of English*  
William A. Damerst, M.A. (Massachusetts) *Professor of English*  
Robert C. S. Downs, M.F.A. (Iowa) *Professor of English*  
Caroline D. Eckhardt, Ph.D. (Michigan) *Associate Professor of English and Comparative Literature*  
Wendell V. Harris, Ph.D. (Wisconsin) *Professor of English*  
Robert N. Hudspeth, Ph.D. (Syracuse) *Associate Professor of English*



Robert D. Hume, Ph.D. (Pennsylvania) *Professor of English*  
 Nicholas A. Joukovsky, D.Phil. (Oxford) *Associate Professor of English*  
 Michael Kiernan, Ph.D. (Harvard) *Associate Professor of English*  
 Arthur O. Lewis, Ph.D. (Penn State) *Professor of English*  
 Robert E. Lougy, Ph.D. (California) *Associate Professor of English*  
 Charles W. Mann, Jr., M.L.S. (Rutgers) *Professor of English*  
 Harrison T. Meserole, Ph.D. (Maryland) *Professor of English*  
 William H. O'Donnell, Ph.D. (Princeton) *Associate Professor of English*  
 Joseph G. Price, Ph.D. (Bryn Mawr) *Professor of English*  
 Audrey T. Rodgers, Ph.D. (Penn State) *Associate Professor of English*  
 Thomas H. Rogers, Ph.D. (Iowa) *Professor of English*  
 Robert A. Secor, Ph.D. (Brown) *Associate Professor of English*  
 John B. Smith, Ph.D. (North Carolina) *Associate Professor of English*  
 Daniel Walden, Ph.D. (New York) *Professor of American Studies*  
 Stanley Weintraub, Ph.D. (Penn State) *Research Professor of English*  
 Paul N. West, M.A. (Columbia) *Professor of English and Comparative Literature*  
 Philip Young, Ph.D. (Iowa) *Evan Pugh Professor of English*

### **Associate Members of the Graduate Faculty**

John D. C. Buck, Ph.D. (California) *Assistant Professor of English*  
 Ronald E. Buckalew, Ph.D. (Illinois) *Associate Professor of English*  
 Wilma R. Ebbitt, Ph.D. (Brown) *Professor of English*  
 Robert P. Fitzgerald, Ph.D. (Iowa) *Associate Professor of English*  
 Richard E. Gidez, Ph.D. (Ohio) *Associate Professor of English*  
 Stephen R. Grecco, M.F.A. (Yale) *Associate Professor of English*  
 John T. Harwood, Ph.D. (Nebraska) *Associate Professor of English*  
 Kathryn Hume, Ph.D. (Pennsylvania) *Associate Professor of English*  
 Theodore E. Kiffer, Ph.D. (Penn State) *Associate Professor of English Linguistics*  
 James R. McAdams, Ph.D. (New York) *Assistant Professor of English*  
 John W. Moore, Jr., Ph.D. (Stanford) *Assistant Professor of English*  
 James M. Rambeau, Ph.D. (Rutgers) *Assistant Professor of English*  
 Peter H. Schneeman, Ph.D. (Minnesota) *Associate Professor of English*  
 John L. Selzer, Ph.D. (Miami) *Assistant Professor of English*  
 Kenneth A. Thigpen, Ph.D. (Indiana) *Associate Professor of English and Comparative Literature*  
 Emily J. Toth, Ph.D. (Johns Hopkins) *Assistant Professor of English*

Candidates for the M.A. in English may specialize in English and American literature, or in writing. Students whose interests are largely in the study of literature, or who intend to continue for the doctorate, specialize in literature. Students who, on the basis of their overall record and a writing sample, are accepted into the writing program may concentrate in the writing of poetry, fiction, or nonfiction, or in editing or business and technical writing. The M.Ed. is offered in cooperation with the College of Education.

The department offers a strong teacher-training program, and most graduate students in English have the opportunity to serve as teaching assistants. Students usually begin by teaching basic composition courses, but there are opportunities for advanced students to teach courses in business writing, technical writing, fiction writing, poetry writing, humanities, and to serve as tutors in the Writing Center.

### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Applicants should have a junior-senior average of 3.20, although exceptions may be made for students with special backgrounds, abilities, and interests.

For admission, M.A. students should have strong backgrounds in English courses: 18 credits beyond freshman composition are a minimum, but the department prefers at least 24 credits. All applicants should submit writing samples indicating their ability to do analytic or original work.

To be considered for the doctoral program, students must have completed an M.A. in English or its equivalent. The records of potential students should indicate promise of superior work in doctoral study.

### Master's Degree Requirements

Candidates for the M.A. take at least 33 credits, 6 of which can be earned by writing a thesis. There is also a 3-credit thesis option, which consists of three substantial essays bound together in consistent format. Each essay must demonstrate the ability to formulate and state meaningfully the results of scholarly investigation or critical analysis. M.A. students with an emphasis in fiction writing or poetry writing may complete their degrees by submitting a body of original work.

M.A. candidates must fulfill the language requirement in one foreign language. All master's candidates are required to take Engl. 501. Other courses are required for students specializing in one of the writing areas. All M.A. candidates must pass an M.A. examination based on a posted list of authors.

Candidates for the M.Ed. take at least 33 credits, 6 of which must be in the College of Education. There are no foreign language or thesis requirements. All M.Ed. candidates must pass the M.A. examination and submit a final paper to the department.

### Doctoral Degree Requirements

The Ph.D. degree does not require a specific number of credits. With the help of departmental graduate advisers, students select a program of small seminars or reading courses. Required courses are Engl. 501, 581, and 6 credits of course work in the area of philology. To complete their programs, students must show reading proficiency in two foreign languages, pass written comprehensive examinations, and write and defend a doctoral dissertation.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

EDWIN EARLE SPARKS DISSERTATION FELLOWSHIP IN THE HUMANITIES — Available to a doctoral candidate in one of the following graduate programs: classics, comparative literature, English, French, German, history, linguistics, philosophy, religious studies, Slavic languages and literatures, Spanish, and speech communication; stipend \$4,800 plus tuition. Apply to relevant department or program before February 1.

EDWIN EARLE SPARKS FELLOWSHIPS IN THE HUMANITIES (8) — Available to beginning graduate students in one of the following graduate programs: classics, comparative literature, English, French, German, history, linguistics, philosophy, religious studies, Slavic languages and literatures, Spanish, and speech communications; stipend \$3,800 plus tuition. Apply to relevant department or program before February 1.

BEN EUWEMA MEMORIAL SCHOLARSHIP — Consideration will be given to all currently enrolled graduate students in English. Preference will be given to students at the Ph.D. thesis stage, particularly those who need to travel to complete their research; number of awards and amount of each award will be determined each year. Applications and thesis proposals should be submitted by May 1.

FOLGER INSTITUTE FELLOWSHIPS — The Pennsylvania State University is a member of the Folger Institute of Renaissance and Eighteenth-Century Studies. Graduate students in English are eligible for Folger Institute Fellowships to study in seminars and workshops at the Folger Library, Washington, D.C.

### ENGLISH (ENGL)

- 407. HISTORY OF THE ENGLISH LANGUAGE (3)
- 408. APPLIED ENGLISH LANGUAGE ANALYSIS (3)
- 410. RHETORICAL THEORY AND PRACTICE (3)
- 411. PROBLEMS OF STYLE (3)
- 412. ADVANCED FICTION WRITING (3-6)
- 413. ADVANCED POETRY WRITING (3-6)
- 414. BIOGRAPHICAL WRITING (3)
- 415. ADVANCED NONFICTION WRITING (3-6)
- 416. (Journ. 416) SCIENCE WRITING (3-6)



417. THE EDITORIAL PROCESS (3)
  418. ADVANCED TECHNICAL WRITING AND EDITING (3-6)
  419. ADVANCED BUSINESS WRITING (3)
  428. THE AMERICAN RENAISSANCE (3)
  432. THE AMERICAN NOVEL TO 1900 (3)
  433. THE AMERICAN NOVEL: 1900-1945 (3)
  435. THE AMERICAN SHORT STORY (3)
  436. AMERICAN FICTION SINCE 1945 (3)
  437. THE POET IN AMERICA (3)
  438. AMERICAN DRAMA (3)
  439. AMERICAN NONFICTION PROSE (3)
  441. CHAUCER (3)
  443. THE ENGLISH RENAISSANCE (3)
  444. SHAKESPEARE (3)
  445. SHAKESPEARE'S CONTEMPORARIES (3)
  446. MILTON (3)
  451. THE RESTORATION AND THE EIGHTEENTH CENTURY (3)
  455. THE ENGLISH NOVEL TO JANE AUSTEN (3)
  460. THE ROMANTICS (3)
  464. THE VICTORIANS (3)
  465. VICTORIAN NOVEL (3)
  470. LITERATURE OF THE BRITISH COMMONWEALTH (3)
  475. MODERN BRITISH FICTION (3)
  477. MODERN POETRY (3)
  478. BRITISH AND IRISH DRAMA SINCE 1890 (3)
  484. (L.A. 484) COMPUTATIONAL AND QUANTITATIVE STYLISTICS (3)
  488. (C.Lit. 488) MODERN CONTINENTAL DRAMA (3)
  490. WOMEN WRITERS AND THEIR WORLDS (3)
  491. LITERATURE FOR TEACHERS IN SECONDARY SCHOOLS (3)
  492. HISTORY OF ENGLISH LITERARY CRITICISM (3)
  493. THE FOLKTALE IN AMERICAN LITERATURE (3)
  494. RESEARCH TOPICS (1-12)
  495. INTERNSHIP (3-6)
  496. INDEPENDENT STUDIES (1-18)
  497. SPECIAL TOPICS (1-9)
  499. FOREIGN STUDY ABROAD — ENGLISH (3-6)
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501. MATERIALS AND METHODS OF RESEARCH (3) Materials and techniques of research in English and American literary history; form and content of theses. Required of all graduate students with an English major.
  502. THEORY AND TEACHING OF COMPOSITION (3) Study of grammar, logic, rhetoric, and style in their applicability to teaching composition.
  506. THE ENGLISH LANGUAGE (3) A problem-centered approach to literary and oral forms of English, utilizing historical and analytic perspectives.
  508. COMPUTER APPLICATIONS FOR WRITERS AND HUMANITIES SCHOLARS (3) Computer applications for writers and humanities scholars: introduction to terminal-editing, retrieval, bibliographic, and textual analysis systems.
  512. THE WRITING OF FICTION (3 per semester, maximum of 9) Supervised workshop in advanced techniques of writing fiction.
  513. THE WRITING OF POETRY (3 per semester, maximum of 9) For the student with considerable experience in writing poetry; a workshop devoted to advanced poetic technique.
  515. THE WRITING OF NONFICTION (3-6) Supervised workshop in advanced nonfiction techniques.

518. BUSINESS AND TECHNICAL WRITING: CURRENT THEORY (3) Intensive examination of current theories and practice in business and technical communication; written projects exploring specific theories and problems.
521. OLD ENGLISH LANGUAGE (3) An introduction to the main features of the Old English language; readings in simple Old English prose and poetry.
522. BEOWULF (3) Reading and critical analysis. Prerequisite: Engl. 521.
540. STUDIES IN ELIZABETHAN PROSE AND POETRY (3-6) Major figures studied will vary from year to year. Writers studied might include figures such as Spenser and Sidney.
541. MEDIEVAL STUDIES (3-6) Studies in medieval English literature. Topics studied might include medieval romances, drama, or major figures aside from Chaucer.
542. MIDDLE ENGLISH LITERATURE (3) Introduction to Middle English and its dialects; study of the literature of the period exclusive of Chaucer.
543. STUDIES IN EARLY SEVENTEENTH-CENTURY LITERATURE (3-6) Major figures studied will vary from year to year. Writers studied might include Donne, Herbert, Jonson, Bacon.
545. CHAUCER (3-6) Major and minor works of Geoffrey Chaucer. The works studied will vary from year to year.
546. MILTON (3) The poetry and prose of John Milton.
548. ELIZABETHAN AND JACOBEAN DRAMA (3-6) English drama from 1558 to 1642, exclusive of Shakespeare.
549. SHAKESPEARE (3-6) Special problems of sources, chronology, text, characterization, and motivation in the drama.
550. ENGLISH LITERATURE 1660-1800 (3 per semester, maximum of 6) Major figures studied will vary from year to year. Writers studied might include Dryden, Swift, Pope, Johnson, Fielding, Gibbon.
551. ENGLISH DRAMA 1660-1800 (3 per semester, maximum of 6) Major figures studied will vary from year to year. Writers studied might include Wycherley, Farquahar, Dryden, Congreve, Etherege.
554. STUDIES IN EARLY AMERICAN LITERATURE (3 per semester, maximum of 6) Major figures studied will vary from year to year. Writers studied might include Bradstreet, Taylor, Mather, Franklin, Edwards, Paine.
556. EIGHTEENTH-CENTURY BRITISH FICTION (3 per semester, maximum of 6) Major figures studied might include Defoe, Smollet, Fielding, Richardson, Sterne.
558. NINETEENTH-CENTURY BRITISH FICTION (3 per semester, maximum of 6) Major figures studied will vary from year to year. Writers studied might include Dickens, Thackeray, the Brontes, George Eliot, Hardy.
559. STUDIES IN TWENTIETH-CENTURY BRITISH FICTION (3 per semester, maximum of 6) Major figures studied will vary from year to year. Writers studied might include Conrad, Lawrence, Woolf, Huxley, Green, Fowles.
560. AMERICAN ROMANTICISM (3 per semester, maximum of 6) Major figures studied will vary from year to year. Writers studied might include Hawthorne, Melville, Emerson, Thoreau, Whitman.
561. STUDIES IN THE ROMANTIC MOVEMENT (3 per semester, maximum of 6) Major figures studied will vary from year to year. Writers studied might include Blake, Wordsworth, Coleridge, Byron, Shelley, Keats.
562. STUDIES IN THE LITERATURE OF VICTORIAN ENGLAND (3 per semester, maximum of 6) Figures will vary from year to year. Writers studied might include Tennyson, Browning, Arnold, Newman, Ruskin, Trollope.
564. STUDIES IN NINETEENTH-CENTURY AMERICAN LITERATURE (3 per semester, maximum of 6) Writers will vary from year to year. Writers studied might include Cooper, Poe, Dickinson, Twain, James.
573. STUDIES IN TWENTIETH-CENTURY BRITISH LITERATURE (3 per semester, maximum of 6) Major figures studied will vary from year to year. Writers studied might include Yeats, Conrad, Joyce, Shaw, Lawrence, Auden.



574. STUDIES IN TWENTIETH-CENTURY AMERICAN LITERATURE (3 per semester, maximum of 6) Figures studied will vary from year to year. Writers studied might include Dreiser, Wharton, Eliot, Hemingway, Fitzgerald, Faulkner, O'Neill, Williams.
575. EXPERIMENTALISM AND MODERNISM IN TWENTIETH-CENTURY BRITISH AND AMERICAN FICTION (3 per semester, maximum of 6) Figures studied will be drawn from the era of Joyce and Virginia Woolf to the present.
576. STUDIES IN TWENTIETH-CENTURY AMERICAN FICTION (3 per semester, maximum of 6) Concentrated study in such major American writers as Hemingway, Faulkner, and Fitzgerald.
578. STUDIES IN MODERN BRITISH DRAMA (3 per semester, maximum of 6) Figures studied will be drawn from the era of Shaw and Wilde to the present.
581. CONTEMPORARY LITERARY CRITICISM (3)
585. STUDIES IN BRITISH FICTION (3 per semester, maximum of 6)
586. READINGS IN LITERATURE (1-12) Programs of readings designed to meet specific needs of individual students.
588. STUDIES IN AMERICAN FICTION (3-6)
589. STUDIES IN AMERICAN POETRY (3-6)
590. COLLOQUIUM (1-3)
595. INTERNSHIP (3-6)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## ENTOMOLOGY (ENT)

CHARLES W. PITTS, *Head of the Department*  
106 Patterson Building  
814-865-1895

**Degrees Conferred:** Ph.D., M.S., M.Agr.

### Senior Members of the Graduate Faculty

Allen W. Benton, Ph.D. (Cornell) *Professor of Entomology*  
Robert A. Byers, Ph.D. (Purdue) *Adjunct Associate Professor of Entomology*  
E. Alan Cameron, Ph.D. (California) *Professor of Entomology*  
Arthur A. Hower, Ph.D. (Penn State) *Professor of Entomology*  
Larry A. Hull, Ph.D. (Penn State) *Assistant Professor of Entomology*  
Gerald G. Jubb, Ph.D. (Arizona) *Associate Professor of Entomology*  
Ke Chung Kim, Ph.D. (Minnesota) *Professor of Entomology*  
Ralph O. Mumma, Ph.D. (Penn State) *Professor of Chemical Pesticides*  
Charles W. Pitts, Ph.D. (Kansas State) *Professor of Entomology*  
Charles W. Rutschky, Ph.D. (Cornell) *Professor of Entomology*  
Zane Smilowitz, Ph.D. (Cornell) *Professor of Entomology*  
Thomas Smyth, Jr., Ph.D. (Johns Hopkins) *Professor of Entomology*  
Robert J. Snetsinger, Ph.D. (Illinois) *Professor of Entomology*  
Robin A. J. Taylor, Ph.D. (London) *Assistant Professor of Entomology*  
William G. Yendol, Ph.D. (Purdue) *Professor of Entomology*

### Associate Members of the Graduate Faculty

William M. Bode, Ph.D. (Ohio State) *Assistant Professor of Entomology*  
Clarence H. Collison, Ph.D. (Michigan State) *Assistant Professor of Entomology Extension*  
David J. Shetlar, Ph.D. (Penn State) *Assistant Professor of Entomology*  
Robert C. Tetrault, Ph.D. (Wisconsin) *Associate Professor of Entomology Extension*  
Alfred G. Wheeler, Jr., Ph.D. (Cornell) *Adjunct Associate Professor of Entomology*

Entomology, the science that deals with insects and related arthropods, specifically attempts to maximize the benefits and minimize the impacts of insects to man by studying their relationships to

plants and animals. The program emphasizes population management of insects and prepares students for a professional career in research, teaching, extension, or industry through advanced studies of structure-function, development, taxonomy, and ecology of insects; principles of integrated pest management; and biological and chemical control techniques. A student also may specialize in the biology and population management of insect pests of agronomic or horticultural crops, forest and ornamental trees or shrubs, commercial mushrooms, and in the toxicology and technology of biological and chemical control. Advanced studies in systematics, ecology, physiology, insect resistance in plants, insect pathology, pesticide chemistry, or pollination biology also may be taken. Modern laboratories, greenhouses, well-equipped research facilities, and field research plots are available for graduate study.

## Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

For admission a student must present 24 credits in biological sciences, including entomology. Chemistry through organic, physics, mathematics through calculus, statistics, and computer application are required. Admission is normally to the M.S. program.

## Master's Degree Requirements

The Master of Agriculture degree in Entomology is a terminal professional degree and is particularly suited for training chemical technical personnel, pest management specialists, and for various government staff positions. A minimum of 30 graduate credits (400 and 500 level) are required, with at least 20 credits earned in residence and 12 credits in Entomology. A maximum of 10 credits may be earned in Special Problems or Special Internship Training. A "term paper" or "internship report" for which up to 3 credits may be given is required. The student must earn at least one seminar credit and must pass a departmental oral examination. These requirements must be met within three calendar years after entering the program.

The Master of Science degree in Entomology is an intermediate degree leading toward the development of special knowledge in entomology. It provides training for prospective doctoral candidates. A minimum of 30 graduate credits, of which 20 must be earned on the University Park Campus, 18 must be graduate courses or research (500 or 600 level), and 12 must be organized graduate-credit courses (400 and 500 level), are required. An acceptable thesis, equivalent to at least 6 credits (600 level), must be submitted. All students must take or have the equivalent of the four core courses (Ent. 413, 414, 415, 416), earn 2 credits of seminar, and pass a departmental oral examination. A minor is not mandatory.

## Doctoral Degree Requirements

The degree of Doctor of Philosophy signifies high scholastic achievement and demonstrated capability in independent research. Although there is no formal credit requirement, it will normally require at least three years of graduate work. Some of the work may be completed off campus or on a part-time basis, but between the time of acceptance as a candidate and completing the degree requirements the student must spend three semesters in residence within a twelve-month period. The department requires that all students have the four core courses or the equivalent (Ent. 413, 414, 415, 416), 10 additional credits in organized graduate courses in the department, 2 credits in departmental seminars, 3 credits in statistics, and two courses outside the department. Each student must take at least one course per semester while in residence. A minor is not required, but a student may elect a minor in general studies or a related field. This consists of no fewer than 15 credits.

The enrichment requirement for the Ph.D. degree may be satisfied by taking at least 9 course credits in a discipline other than entomology. There is no foreign language requirement for the Ph.D. degree. However, depending on the nature of the thesis research and with the advice and consent of the Doctoral Committee, competency in a foreign language may be required as a part of the doctoral studies of certain students.

## Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.



**ENTOMOLOGY (ENT)**

- 401. MEDICAL AND VETERINARY ENTOMOLOGY (3) *Kim*
  - 412. FIELD ENTOMOLOGY (3) *Rutschky*
  - 413. INSECT IDENTIFICATION (3)
  - 414. INSECT MORPHOLOGY (3) *Rutschky*
  - 415. INSECT PHYSIOLOGY (3) *Mumma and Smyth*
  - 416. TACTICS FOR INSECT PEST CONTROL (3) *Hoover*
  - 418. FOREST ENTOMOLOGY (3) *Cameron*
  - 425. FRESHWATER ENTOMOLOGY (3) *Kim*
  - 426. IMMATURE INSECTS (3) *Shetlar*
  - 435. ARACHNOLOGY (3) *Snetsinger*
  - 450. INSECT CONTROL IN GREENHOUSE (1) *Shetlar and Snetsinger*
  - 451. INSECT CONTROL OF ORNAMENTALS AND TURF (2) *Shetlar*
  - 452. URBAN ENTOMOLOGY (2) *Snetsinger*
  - 455. ADVANCED ECONOMIC ENTOMOLOGY (3) *Pitts*
  - 496. INDEPENDENT STUDIES (1-18)
  - 497. SPECIAL TOPICS (1-9)
- 
- 515. INSECT MORPHOLOGY AND SYSTEMATICS (1-3) Current theories, controversies, and advanced techniques in comparative morphology, histology, embryonic and postembryonic development, taxonomy and systematics of insects.
  - 516. INSECT PHYSIOLOGY AND BIOCHEMISTRY (1-3) Selected topics in insect function and metabolism.
  - 517. INSECT ECOLOGY AND BEHAVIOR (1-3) Selected aspects of the biotic and abiotic interactions of insects.
  - 518. PEST MANAGEMENT (1-3) Current concepts and controversies in modern agricultural and urban pest management practice.
  - 522. POPULATION MODELING (3) Mathematical techniques for modeling biological systems; analysis of dynamics of applicable mathematical models; review of existing population models. Prerequisite: Ent. 551.
  - 530. HOST PLANT RESISTANCE TO INSECTS (2) Evaluation and identification of plant resistance to insect and mite attack. Prerequisites: 10 credits in entomology and/or plant science.
  - 531. INSECT TOXICOLOGY (2) General principles of toxicology and survey of the actions of substances toxic to insects.
  - 535. BIOLOGICAL CONTROL (3) Practical and theoretical aspects of arthropod control by entomophagous insects and the place of biocontrol in integrated control programs.
  - 536. INSECT PATHOLOGY (3) Diseases of arthropods and some aspects of microbial control of insects. Prerequisite: Micrb. 201.
  - 538. INSECT TAXONOMY (3) Taxonomic literature, history, concepts, principles, techniques; nomenclature; classification and identification of major taxa; insect phylogeny and evolutionary trends. Prerequisites: Ent. 413; Ent. 12 or 300.
  - 542. (Biol. 542) SYSTEMATICS (3) Principles and methods of classification, phylogeny, and speciation; taxonomic techniques; analysis of species, causal interpretation of animal diversity.
  - 551. INSECT POPULATION ECOLOGY (3) Principles, theory, and practice of insect population dynamics; identification and measurement of properties of biological populations affecting distribution and abundance. Prerequisites: Biol. 210, Cmp.Sc. 101, Stat. 250.
  - 590. COLLOQUIUM (1-3)
  - 596. INDIVIDUAL STUDIES (1-9)
  - 597. SPECIAL TOPICS (1-9)
  - 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## ENVIRONMENTAL ENGINEERING (ENV E)

ROBERT M. BARNOFF, *Head of the Department of Civil Engineering*  
212 Sackett Building  
814-865-8391

**Degrees Conferred:** Ph.D., M.S., M.Eng.

### Senior Members of the Graduate Faculty

Gert Aron, Ph.D. (California), P.E. *Professor of Civil Engineering*  
Robert M. Barnoff, Ph.D. (Carnegie Tech.), P.E., P.L.S. *Professor of Civil Engineering*  
Robert J. Heinsohn, Ph.D. (Michigan State) *Professor of Mechanical Engineering*  
David F. Kibler, Ph.D. (Colorado State), P.E. *Professor of Civil Engineering*  
David A. Long, Ph.D. (Penn State), P.E. *Associate Professor of Civil Engineering*  
Archibald J. McDonnell, Ph.D. (Penn State) *Professor of Civil Engineering*  
Arthur C. Miller, Ph.D. (Colorado State), P.E. *Associate Professor of Civil Engineering*  
John B. Nesbitt, Sc.D. (M.I.T.) *Professor of Civil Engineering*  
Joseph R. Reed, Ph.D. (Cornell), P.E. *Associate Professor of Civil Engineering*  
Raymond W. Regan, Ph.D. (Kansas), P.E. *Associate Professor of Civil Engineering*  
Richard F. Unz, Ph.D. (Rutgers) *Professor of Environmental Microbiology*

This program prepares students for careers in (1) facility and system design; (2) systems management; (3) environmental monitoring; (4) process development; or (5) education and research in any of the environmental areas of water quality management (potable, industrial, and wastewater), water resources management, and air pollution control.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

The entering student normally should be a graduate from an accredited program in engineering. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. Applicants must submit Graduate Record Examination Aptitude test scores. Entering graduate students for whom English is not the first language are required to have a score of at least 560 on the TOEFL (Test of English as a Foreign Language) examination. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

### Degree Requirements

In addition to demonstrating competence in English, each candidate for the Ph.D. degree must meet a foreign language or communication skills requirement established by the department. A thesis is required for the M.S. degree. An engineering report is required for the M.Eng. degree.

### Other Relevant Information

The following courses offered by the Department of Civil Engineering are appropriate for students majoring in Environmental Engineering (course descriptions are given under Civil Engineering): C.E. 451, 462, 465, 471, 472, 474, 475, 476, 496, 497, 551, 553, 554, 564, 570, 571, 572, 574, 575, 577, 579, 580, 596, and 597. Appropriate courses offered by other departments include Bioch. 401, 402, 425; Chem. 405; Geosc. 452; I.E. 403, 405, 509, 510; M.E. 405, 470, 521, 571; Meteo. 454; Micrb. 400; Nuc.E. 420; P.Path. 424; Pl.Sc. 419; Pub.A. 578; R.Pl. 400, 410, 510, 520.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

W. S. ELLIOTT FELLOWSHIP — Available to a graduate student who is a graduate of The Pennsyl-



vania State University and is interested in engineering research; stipend variable. Apply to Office of the Dean, College of Engineering, 101 Hammond Building.

**TAU BETA PI FELLOWSHIP** — Open to any member of Tau Beta Pi, the engineering honor society, for a year of advanced study. Up to eighteen awards of \$3,500 each are available. Applications and information may be obtained from the Office of the Dean, College of Engineering, 101 Hammond Building. Application deadline is February 15.

## ENVIRONMENTAL POLLUTION CONTROL (E P C)

JOHN B. NESBITT, *In Charge of Graduate Programs in Environmental Pollution Control*  
226 Merrell R. Fenske Laboratory  
814-865-1415

**Degrees Conferred:** M.S., M.E.P.C., M.Eng.

### Senior Members of the Graduate Faculty (University Park)

Frank F. Aplan, Sc.D. (M.I.T.) *Professor of Metallurgy and Mineral Processing*  
Gert Aron, Ph.D. (California), P.E. *Associate Professor of Civil Engineering*  
Dale E. Baker, Ph.D. (Missouri) *Professor of Soil Chemistry*  
Paul Barton, Ph.D. (Penn State), P.E. *Assistant Professor of Chemical Engineering*  
Elsworth R. Buskirk, Ph.D. (Minnesota) *Professor of Applied Physiology*  
Robert L. Cunningham, Ph.D. (Washington State) *Professor of Soil Genesis and Morphology*  
Paul A. de Maine, Ph.D. (British Columbia) *Professor of Computer Science*  
Rosa G. de Pena, Ph.D. (Buenos Aires) *Professor of Meteorology*  
David R. DeWalle, Ph.D. (Colorado State) *Professor of Forest Hydrology*  
Alan B. Draper, Ph.D. (Illinois) *Professor of Industrial Engineering*  
Alfred J. Engel, Ph.D. (Wisconsin) *Professor of Chemical Engineering*  
Richard L. Gordon, Ph.D. (M.I.T.) *Professor of Mineral Economics*  
Julian P. Hecklen, Ph.D. (Rochester) *Professor of Chemistry*  
Robert J. Heinsohn, Ph.D. (Michigan State) *Professor of Mechanical Engineering*  
Vilma R. Hunt, A.M. (Radcliffe) *Professor of Environmental Health*  
Robert L. Kabel, Ph.D. (Washington), P.E. *Professor of Chemical Engineering*  
Eliezer Kamon, Ph.D. (Hebrew, Jerusalem) *Professor of Applied Physiology and Ergonomics*  
C. Gregory Knight, Ph.D. (Minnesota) *Professor of Geography*  
Manfred Kroger, Ph.D. (Penn State) *Professor of Food Science*  
David A. Long, Ph.D. (Penn State), P.E. *Professor of Civil Engineering*  
James A. Lynch, Ph.D. (Penn State) *Associate Professor of Forest Hydrology*  
Edward J. Massaro, Ph.D. (Texas) *Professor of Veterinary Science*  
Archibald J. McDonnell, Ph.D. (Penn State) *Professor of Civil Engineering*  
Guy W. McKee, Ph.D. (Penn State) *Professor of Agronomy*  
Paul L. Michael, Ph.D. (Pittsburgh) *Professor of Environmental Acoustics*  
Arthur C. Miller, Ph.D. (Colorado State) *Associate Professor of Civil Engineering*  
John B. Nesbitt, Sc.D. (M.I.T.) *Professor of Civil Engineering*  
Howard B. Palmer, Ph.D. (Wisconsin) *Professor of Energy Science*  
Hans A. Panofsky, Ph.D. (California) *Evan Pugh Professor of Atmospheric Sciences*  
Richard R. Parizek, Ph.D. (Illinois) *Professor of Geology*  
Gary W. Petersen, Ph.D. (Wisconsin) *Professor of Soil Genesis and Morphology*  
Gérhard Reethof, Sc.D. (M.I.T.) *Professor of Mechanical Engineering*  
Raymond W. Regan, Ph.D. (Kansas), P.E. *Associate Professor of Civil Engineering*  
Andrew S. Rogowski, Ph.D. (Iowa State) *Adjunct Associate Professor of Soil Physics*  
George H. K. Schenck, Ph.D. (Penn State) *Associate Professor of Mineral Economics*  
George Simkovich, Ph.D. (Penn State) *Professor of Metallurgy*  
William E. Sopper, Ph.D. (Yale) *Professor of Forest Hydrology*  
C. Drew Stahl, Ph.D. (Penn State) *Professor of Petroleum and Natural Gas Engineering*  
Kermit Q. Stephenson, M.S. (Arkansas), P.E. *Professor of Agricultural Engineering*  
John M. Tarbell, Ph.D. (Delaware) *Associate Professor of Chemical Engineering*  
Dennis W. Thomson, Ph.D. (Wisconsin) *Professor of Meteorology*  
Richard F. Unz, Ph.D. (Rutgers) *Associate Professor of Sanitary Microbiology*  
Philip L. Walker, Jr., Ph.D. (Penn State) *Evan Pugh Professor of Materials Science*  
William B. White, Ph.D. (Penn State) *Professor of Geochemistry*  
Warren F. Witzig, Ph.D. (Pittsburgh) *Professor of Nuclear Engineering*  
Arian Zarkower, Ph.D. (Cornell) *Associate Professor of Veterinary Science*

## **Associate Members of the Graduate Faculty (University Park)**

Gordon R. Bienvenue, Ph.D. (Penn State) *Research Associate in Audiology*  
 John W. Davis, Ph.D. (Penn State) *Research Associate, Center for Air Environment Studies*  
 Frederick G. Ferguson, Ph.D. (Pennsylvania) *Professor of Veterinary Science*  
 Albert R. Jarrett, Ph.D. (Penn State) *Associate Professor of Agricultural Engineering*  
 Robert G. Jenkins, Ph.D. (Leeds) *Associate Professor of Fuel Science*  
 David F. Kibler, Ph.D. (Colorado State) *Professor of Civil Engineering*  
 Stanley P. Mayers, Jr., M.D. (Pennsylvania) *Professor of Health Care Planning*  
 William H. Patton, Ph.D. (Wisconsin) *Assistant Professor of Veterinary Science*  
 James J. Reuther, Ph.D. (Penn State) *Assistant Professor of Fuel Science*  
 William E. Sharpe, Ph.D. (West Virginia) *Assistant Professor of Forest Resources Extension*

## **Senior Members of the Graduate Faculty (Capitol Campus)**

Barnard H. Bissinger, Ph.D. (Cornell) *Professor of Mathematics*  
 Charles A. Cole, Ph.D. (Rutgers) *Professor of Engineering*  
 Francis Ferguson, Ph.D. (Columbia) *Professor of Environmental Design*  
 Irving Hand, M.C.P. (M.I.T.) *Associate Professor of State and Regional Planning*  
 Robert E. McDermott, Ph.D. (Duke) *Professor of Forestry*  
 Christopher K. McKenna, Ph.D. (New York) *Associate Professor of Management Science*  
 Robert F. Munzenrider, Ph.D. (Georgia) *Associate Professor of Public Administration*  
 James E. Skok, Ph.D. (Maryland) *Associate Professor of Public Administration*

## **Associate Members of the Graduate Faculty (Capitol Campus)**

Robert J. Brown, Ph.D. (New York) *Associate Professor of Finance*  
 Eli D. Buskirk, Jr., Ph.D. (Michigan) *Assistant Professor of Regional Planning*  
 Rupert F. Chisholm, Ph.D. (Case Western Reserve) *Assistant Professor of Management*  
 Vedula N. Murty, Ph.D. (Purdue) *Professor of Mathematics and Statistics*  
 Daniel M. Poore, Ph.D. (Pittsburgh) *Associate Professor of Administration*  
 Jerome J. Przybylski, Ph.D. (Western Michigan) *Assistant Professor of Mathematics and Statistics*  
 Gujar N. S. Rap, Ph.D. (Oklahoma) *Assistant Professor of Engineering*  
 Robert A. Simko, Ph.D. (Indiana) *Associate Professor of Geography and Social Science*  
 Lorna C. Stoltzfus, M.S. (Hunter) *Assistant Professor of Chemistry*  
 James B. Stong, M.S. (Kansas) *Assistant Professor of Engineering*  
 Clifford H. Wagner, Ph.D. (S.U.N.Y.) *Associate Professor of Mathematics*  
 Lloyd W. Woodruff, Ph.D. (Minnesota) *Associate Professor of Public Administration*

This intercollege master's degree program, available at both the University Park and Capitol campuses, deals with the various aspects of the control of air and water pollution and the disposal of solid wastes. Options in air, water, solid waste, and occupational health are available. Graduate instruction is under the direction of an interdisciplinary faculty committee and the departments participating in the program. The graduate faculty consists of members who have teaching and/or research interests in the area of environmental pollution control. Currently fifty-six faculty from twenty departments representing seven colleges are participating in the program at University Park; twenty faculty and four graduate programs participate at Capitol Campus. A student is affiliated with one of these departments on the basis of his or her specific area of interest and is advised by an E.P.C. faculty member in that department. Maximum flexibility is maintained by the program in an effort to meet both the needs of the individual student and the pollution control activity in which he or she wishes to participate. Nearly all of the graduate faculty members are actively involved in environmental research relating to their field of expertise and, where projects are being supported by departmental funds or with outside funding, research opportunities are available.

## **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

The E.P.C. program is designed for students with backgrounds in science and engineering. Admission will be granted upon recommendation of the head of the academic department with which the student wishes to affiliate and the E.P.C. program chairman. Normal admission requirements include mathematics through integral calculus plus two courses each in both general chemistry and physics. For those who have no water quality courses in their undergraduate background or in related work



experience, a course in water pollution control (C.E. 370) also is required. It is strongly advised that students take this course by a Penn State correspondence course prior to entry into the E.P.C. program. There is no foreign language requirement.

Students with a 3.00 junior-senior average and with appropriate backgrounds in mathematics and science will be considered for admission. The best-qualified applicants will be accepted. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. Entering graduate students for whom English is not the first language are required to have a score of at least 560 on the TOEFL (Test of English as a Foreign Language) examination.

### **Degree Requirements**

Students are required to pass 9 credits of core courses: C.E. 472, Water Pollution Control Processes; C.E. 476, Solid Waste Management; and M.E. 470, Fundamentals of Air Pollution. In addition, all but 6 of their total 30 credits must be selected from a recommended course list, and this must include 2 semester credits of the environmental pollution control seminar series (E.P.C. 590). If the option to prepare a thesis is selected, the student must schedule at least 18 credits at the 500 and 600 levels. The thesis research topic must be in the area of environmental pollution control, and at least 6 credits of research must be taken in the department with which the student is affiliated. Students who select the nonthesis option must schedule at least 9 credits at the 500 level, which may not include the seminar credits or any paper writing credits, and must submit a master's paper. The student's adviser, the department head, and the E.P.C. program chairman determine the specific requirements of this paper.

### **Student Aids**

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## **ENVIRONMENTAL POLLUTION CONTROL (E P C)**

590. COLLOQUIUM (1-3)

## **EXTENSION EDUCATION (EXTED)**

WILLIAM I. LINDLEY, *Chairman of the Committee on Extension Education*  
Armsby Building  
814-863-0387

**Degrees Conferred:** M.Agr., M.Ed.

### **Senior Members of the Graduate Faculty**

Gerald D. Kuhn, Ph.D. (Purdue) *Professor of Food Science Extension*  
C. Marshall Ritter, Ph.D. (Ohio State) *Professor of Pomology*  
Grant W. Sherritt, Ph.D. (Penn State) *Associate Professor of Animal Science*  
Robert J. Snetsinger, Ph.D. (Illinois) *Professor of Entomology*  
Paul J. Wuest, Ph.D. (Penn State) *Professor of Plant Pathology*

### **Associate Members of the Graduate Faculty**

Richard H. Cole, Ph.D. (Penn State) *Associate Professor of Horticulture Extension and Agronomy*  
O. Elwood Hatley, Ph.D. (Purdue) *Associate Professor of Agronomy Extension*  
Daryl K. Heasley, Ph.D. (Penn State) *Associate Professor of Rural Sociology Extension*  
William I. Lindley, Ph.D. (Cornell) *Assistant Professor of Agricultural Education and Agricultural Extension*  
Dennis J. Murphy, Ph.D. (Cornell) *Assistant Professor of Agricultural Engineering Extension*  
Jerry H. Reyburn, Ph.D. (Purdue) *Associate Professor of 4-H Youth Extension*  
Paul R. Shellenberger, Ph.D. (Iowa State) *Professor of Dairy Science*

This program is designed to meet the graduate study needs of professionals in various extension, vocational, and adult education positions. Students are required to select a committee to assist in defining professional goals, planning a program of study, selecting appropriate courses, and developing a professional paper within the requirements of the degree program.

Specific objectives of the Extension Education program are (1) to provide a comprehensive program of study that focuses on developing, evaluating, and administering Cooperative Extension and other nonformal education programs; (2) to promote an awareness and understanding of significant

research in the area of Extension Education; (3) to increase the professional effectiveness of extension personnel; (4) to provide experience in research methodology problem solving and its application by extension personnel.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Admission requirements include a baccalaureate degree from an accredited institution, and it is preferred that students have a strong background in agriculture or home economics and a minimum of 12 credits in the social sciences. Students with at least a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students.

TOEFL scores are required for all students with English as a second language. Published Graduate School requirements apply in all cases.

### Degree Requirements

For either degree, a minimum of 30 credits is required, including a 3-credit professional paper. These credits should be distributed as follows: 12 credits in extension techniques, communication, and education; 3-4 credits in statistics; at least 6 credits in a minor area of interest; up to 6 credits as electives; and 3 credits for the professional paper. For the M.Ed. degree, a minimum of 6 credits in education courses are required. It is suggested that 12 of the 27 credits in course work be taken at the 500 level. A maximum of 10 credits can be earned as a nonresident student.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## EXTENSION EDUCATION (EXTED)

515. (R.Soc. 515) THE COOPERATIVE EXTENSION ORGANIZATION (3) The Cooperative Extension Service as a social system, with emphasis on techniques of organization and program development. Prerequisites: 9 credits in education, communication, and/or social sciences. *Thomson*

## FOOD SCIENCE (FD SC)

PHILIP G. KEENEY, *Interim Head of the Department*  
111 Borland Laboratory  
814-865-5444

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Robert B. Beelman, Ph.D. (Ohio State) *Professor of Food Science*  
Paul S. Dimick, Ph.D. (Penn State) *Professor of Food Science*  
Philip G. Keeney, Ph.D. (Penn State) *Professor of Food Science*  
Arun Kilara, Ph.D. (Nebraska) *Assistant Professor of Food Science*  
Manfred Kroger, Ph.D. (Penn State) *Professor of Food Science*  
Gerald D. Kuhn, Ph.D. (Purdue) *Professor of Food Science Extension*  
Joseph H. MacNeil, Ph.D. (Michigan State) *Professor of Food Science*  
Michael E. Mason, Ph.D. (Oklahoma State) *Adjunct Professor of Food Science*  
Morris G. Mast, Ph.D. (Ohio State) *Professor of Food Science*  
Robert D. McCarthy, Ph.D. (Maryland) *Professor of Food Science*  
Marvin P. Thompson, Ph.D. (Michigan State) *Adjunct Professor of Food Science*  
John H. Ziegler, Ph.D. (Penn State) *Professor of Meat Science*



**Associate Members of the Graduate Faculty**

Stephanie Doores, Ph.D. (Maryland) *Assistant Professor of Food Science*  
 Richard H. Forsythe, Ph.D. (Iowa State) *Adjunct Professor of Food Science*  
 Edward D. Glass, Jr., Ph.D. (Penn State) *Associate Professor of Food Science*  
 J. Scott Smith, Ph.D. (Penn State) *Assistant Professor of Food Science*

Food is directly related to human beings' health and social and political well-being. As a consequence, many well-qualified individuals will be seeking graduate education and training in this important area. The nature of graduate work leading to the M.S. and Ph.D. degrees in Food Science is not simply an extension of the undergraduate program with more courses at a higher level. Rather, it is directed toward establishing the individual as a professional leader and an independent scholar capable of tending to his or her own professional education needs for the rest of his or her life. Opportunities are available for study in the fields of biochemistry and metabolism, food chemistry (carbohydrates, lipids, proteins, enzymes), microbiology, quality control, flavor control and acceptance, product evaluation and processing. Special emphasis can be devoted to dairy, meat, plant, and poultry products, and other specific food commodities. Because of the indispensable role that research plays in the educational and cultural advancement of humanity, it is a central requirement of the Food Science program that graduate students participate in the departmental research program and develop their talents for conducting research.

**Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Students with a 3.00 junior-senior average will be considered for admission to the program, subject to limitations of physical facilities. Exceptions may be made for students with special backgrounds, abilities, and interests.

Prerequisite to graduate work is the completion of an undergraduate degree in food science, biochemistry, microbiology, or other related areas. The undergraduate program must include calculus, organic chemistry, microbiology, and general physics. Students may be admitted with deficiencies but are required to make them up without degree credit.

Students are generally admitted directly to a master's program unless they have previously earned an M.S. degree in food science or an appropriate related area; in such cases, admission can be made directly to the doctoral program by approval of the graduate program committee.

**Master's Degree Requirements**

The requirements for the M.S. program are detailed in the Department of Food Science's publication "Graduate Programs in Food Science." Minimum course requirements for the M.S. degree are as follows: Colloquium (Fd.Sc. 590), 2 credits; Food Science courses, 9 credits; related courses, 3 credits; Chemistry/Biochemistry courses (400 or 500 level), 6 credits; research (Fd.Sc. 600 or 601), 6 credits.

**Doctoral Degree Requirements**

The requirements for the Ph.D. program are detailed in the Department of Food Science's publication "Graduate Programs in Food Science."

The communications and foreign language requirement for the Ph.D. degree must be satisfied before taking the comprehensive examination by either of the following two options:

**Option A.** Competence in reading, writing, and speaking one foreign language at the level normally attained by completing at least two sequence courses of undergraduate work (or 6 credits of 1G and 2G) in a language approved by the committee. This option may be satisfied by obtaining at least a grade of B in the final course of a language sequence or by passing a reading proficiency examination given by a language department.

## FOOD SCIENCE

*Option B.* Pass three courses from at least two of the following areas (one of the courses must be at the 400 or 500 level):

1. Technical writing
2. Speech
3. College or extension teaching
4. Logic or philosophy of science

A grade of at least B must be earned in 100-399 courses.

Minimum course requirements for the Ph.D. degree are as follows: Colloquium (Fd.Sc. 590), 4 credits; Food Science courses, 12 credits; related courses, 6 credits; Chemistry/Biochemistry courses (400 or 500 level), 9 credits; research (Fd.Sc. 600 or 610), 6 credits.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## FOOD SCIENCE (FD SC)

- 400. FOOD CHEMISTRY (3)
- 403. QUALITY ASSURANCE AND SANITATION (3)
- 404. SENSORY EVALUATION OF FOODS (2)
- 405. THERMAL PROCESSING (2)
- 407. FOOD TOXINS (2)
- 408. APPLIED FOOD MICROBIOLOGY (2)
- 409. LABORATORY IN APPLIED FOOD MICROBIOLOGY (2)
- 410. CHEMICAL METHODS OF FOOD ANALYSIS (4)
- 415. MEAT SCIENCE AND TECHNOLOGY (3)
- 420. ADVANCED POULTRY, MEAT, AND FISH TECHNOLOGY (4)
- 490. UNDERGRADUATE SEMINAR (1)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 505. CONCEPTS OF PRODUCT DEVELOPMENT (2) Procedures and problems encountered in the development of new and modified food products. Idea generation through development, testing, and commercialization.
- 507. FOOD QUALITY, FOOD STANDARDS, AND CONSUMER PROTECTION (2) Problems of the food industry relating to contamination and quality of food products.
- 508. FOOD PROTEINS AND ENZYME TECHNOLOGY (3) Properties and uses of proteins and enzymes in foods and food processing.
- 515. EXPERIMENTAL MEAT SCIENCE AND MUSCLE BIOLOGY (2-6) Experimental and theoretical aspects of meat science, meat product/process systems, and the quantitative biology of muscle systems used for food. Prerequisite: Fd.Sc. 400 or 415.
- 521. RADIOBIOLOGY (3) Radioactivity: its nature, interaction with matter, measurement, and quantification; the use of isotopes as tracers in biological systems.
- 522. RESEARCH PROCEDURES IN FOOD SCIENCE (3) Research problems and methods in food science, with major emphasis on food chemistry.
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)



## FOREST RESOURCES (FOR R)

ROBERT S. BOND, *Director of the School of Forest Resources*  
101 Ferguson Building  
814-865-7541

**Degrees Conferred:** Ph.D., M.S., M.Agr., M.F.R.

### Senior Members of the Graduate Faculty

Dean E. Arnold, Ph.D. (Cornell) *Adjunct Assistant Professor of Aquatic Ecology*  
Robert C. Baldwin, Ph.D. (Penn State) *Assistant Professor of Wood Science and Technology*  
Paul R. Blankenhorn, Ph.D. (Penn State) *Associate Professor of Wood Technology*  
Robert S. Bond, Ph.D. (S.U.N.Y.) *Professor of Forest Resources*  
Todd W. Bowersox, Ph.D. (Penn State) *Associate Professor of Silviculture*  
David R. DeWalle, Ph.D. (Colorado) *Professor of Forest Hydrology*  
Henry D. Gerhold, Ph.D. (Yale) *Professor of Forest Genetics*  
Russell J. Hutnik, Ph.D. (Duke) *Professor of Forest Ecology*  
Peter Labosky, Ph.D. (Virginia Polytechnic) *Associate Professor of Wood Science and Technology*  
James A. Lynch, Ph.D. (Penn State) *Associate Professor of Forest Hydrology*  
Larry H. McCormick, Ph.D. (Penn State) *Assistant Professor of Forest Resources*  
Wayne L. Myers, Ph.D. (Michigan) *Associate Professor of Forest Biometrics*  
Robert D. Shipman, Ph.D. (Michigan State) *Professor of Forest Ecology*  
William E. Sopper, Ph.D. (Yale) *Professor of Forest Hydrology*  
Kim C. Steiner, Ph.D. (Michigan State) *Associate Professor of Forest Genetics*  
Gerald L. Storm, Ph.D. (Minnesota) *Adjunct Assistant Professor of Wildlife*  
Brian J. Turner, Ph.D. (Yale) *Associate Professor of Forest Management*  
Ben W. Twight, Ph.D. (Washington) *Associate Professor of Forest Resources*  
James S. Wakeley, Ph.D. (Utah) *Associate Professor of Wildlife Ecology*  
Richard H. Yahner, Ph.D. (Ohio) *Assistant Professor of Wildlife Management*

### Associate Members of the Graduate Faculty

Robert P. Brooks, Ph.D. (Massachusetts) *Assistant Professor of Wildlife Technology*  
Edward S. Corbett, Ph.D. (Penn State) *Adjunct Assistant Professor of Forest Resources*  
Howard G. Halverson, Ph.D. (Arizona) *Adjunct Associate Professor of Forest Resources*  
Gordon M. Heisler, Ph.D. (S.U.N.Y.) *Adjunct Assistant Professor of Forest Resources*  
Walter W. Johnson, Ph.D. (Oregon State) *Associate Professor of Forest Resources Extension*  
Paul C. Kersavage, Ph.D. (Michigan) *Assistant Professor of Wood Technology*  
Rex E. Melton, M.F. (Michigan) *Professor of Forestry*  
Bruce E. Michie, Ph.D. (Wisconsin) *Assistant Professor of Forest Resources*  
Terry D. Rader, Ph.D. (Cornell) *Associate Professor of Forest Resources Extension*  
William E. Sharpe, Ph.D. (West Virginia) *Assistant Professor of Forest Resources Extension*  
Charles H. Strauss, Ph.D. (Penn State) *Associate Professor of Forest Economics*  
Walter M. Tzilkowski, Ph.D. (Massachusetts) *Assistant Professor of Wildlife Science*

The Doctor of Philosophy and the Master of Science degree programs are oriented toward research, education, and scientific technology in the professions of forest products, forestry, and wildlife management. The Master of Forest Resources is a professional degree which emphasizes application of knowledge through managerial practices involving forest resources, industries, or the natural environments of communities and recreational areas. The Master of Agriculture is intended to enable students to develop skills as professionals in the communication of technical knowledge.

Faculty expertise, laboratories, and outdoor facilities are available to support specialization in a variety of fields. Possibilities for specialization are indicated in part by the courses listed under forest products, forestry, and wildlife, and by related courses in agricultural economics, agronomy, animal nutrition, biology, business administration, chemical engineering, computer science, ecology, economics, entomology, environmental pollution control, environmental resource management, genetics, horticulture, industrial engineering, landscape architecture, meteorology, physiology, plant pathology, polymer sciences, recreation and parks, regional planning, or statistics.

Students in this program may elect the dual-title degree program option in Operations Research for the Ph.D. and M.S. degrees (see p. 285).

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for*

*graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Application materials should be submitted before February by those who want to begin in summer or fall. For admission, an applicant should have at least a 2.75 grade-point average, a 3.00 junior-senior average, and courses that are basic to the individual's field of specialization. Ordinarily, these include 12 credits in communication; 12 credits in social sciences and humanities; 12 credits in quantification, including calculus and statistics; 8 credits in chemistry and/or physics; 8 credits in biological sciences; and 18 credits in forest products, forestry, wildlife, or related courses. Graduate Record Examination scores, three reference reports (forms supplied on request), and a brief statement describing the applicant's academic goals, career interests, and special qualifications are required. The best-qualified applicants will be accepted up to the number of spaces available. Exceptions to admission requirements may be made for students with special backgrounds, abilities and interests.

Admission to the Ph.D. program in Forest Resources requires a completed master's thesis or a B.S. with research experience and publication.

### **Master's Degree Requirements**

**M.S.:** In addition to Graduate School requirements, 6 credits of statistics and 2 credits of colloquium are required. A *Research Brief* must accompany the thesis when submitted for the director's signature.

**M.F.R.:** A minimum of 30 graduate credits is required, of which at least 20 must be earned at an established graduate campus of the University. At least 12 credits must be in courses at the 500 level, excluding 596, and 6 credits of statistics are required. Each candidate is required to submit an acceptable paper which demonstrates an ability to apply to the professional field the knowledge gained during his or her program. Six to 9 credits will be given for this paper, which will be evaluated by the student's committee and defended in an oral exam.

**M.Agr.:** Candidates will elect a minimum of 15 credits of graduate-level courses in departments such as Agricultural Education, Journalism, Recreation and Parks, Speech Communication, English, and Theatre. Any deficiencies in a student's resource specialty, as judged by his or her advisory committee, must be remedied. An acceptable paper on a selected professional problem or a report of internship training worth 3 credits or more is also required.

### **Doctoral Degree Requirements**

The foreign language requirement for the Ph.D. degree may be satisfied by demonstrating competence in one foreign language equivalent to passing three college-level courses. With approval of their doctoral committee, students may petition the Graduate Faculty of the school for waiver of the foreign language requirement.

Postbaccalaureate course work will include courses specified for the M.S. degree plus 2 credits of colloquium. The entire program of courses tailored to the student's objectives is subject to approval of the student's committee.

The comprehensive examination will consist of an oral and written portion, the written coming first. Copies of the student's thesis research proposal should be provided to the committee before the comprehensive examination.

### **Other Relevant Information**

Each entering student receives individual guidance from an adviser, and later from his or her committee, in designing a program of studies and research based on his or her own interests. The student is responsible for conforming to all requirements summarized in the "Graduate Studies Handbook" of the School of Forest Resources, and for completing the degree program within a reasonable time, i.e., two years for a master's degree or three years for a Ph.D.

### **Student Aids**

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

**FOREST RESOURCES: JESSE ROSSITER RAPP MEMORIAL SCHOLARSHIP** — Available to graduate students in the School of Forest Resources who are not holding assistantships as graduate students. Apply to the School of Forest Resources' Scholarships, Loans, and Awards Committee.

**ROGER M. LATHAM MEMORIAL AWARD** — Awarded to outstanding graduate students specializing in wildlife management after at least one semester in residence.



**FOREST PRODUCTS (F P)**

- 411. WOOD-ENVIRONMENTAL RELATIONSHIPS (3)
  - 412. WOOD IN STRUCTURES (3)
  - 413. THE CHEMISTRY OF WOOD (3)
  - 414. PULP AND FIBER TECHNOLOGY (3)
  - 415. FOREST PRODUCTS MANUFACTURING SYSTEMS AND PROCESSES (3)
  - 416. WOOD ADHESIVES, FINISHES, AND COMPOSITES (4)
  - 422. DRYING OF WOOD (2)
  - 423. DETERIORATION AND PROTECTION OF WOOD PRODUCTS (2)
  - 432. FOREST PRODUCTS QUALITY STANDARDS (3)
  - 435. FOREST PRODUCTS PRODUCTION MANAGEMENT AND MARKETING (3)
  - 490. FOREST PRODUCTS COLLOQUIUM (1)
  - 495. FOREST PRODUCTS INTERNSHIP (1-6)
  - 496. INDEPENDENT STUDIES (1-18)
  - 497. SPECIAL TOPICS (1-9)
502. WOOD FIBERS (3) Identification and measurement of physical and chemical characteristics of wood fibers used in paper or dissolving pulps.
511. PHYSICAL PROPERTIES OF WOOD AND FIBERS (3) Theories of moisture, diffusion, permeability, and heat transport; ultrastructure and thermal properties of wood and fibers. Prerequisite: F.P. 411.
513. WOOD CHEMISTRY (3) Treatment of the chemical components of wood, their distribution and reactions. Prerequisite: F.P. 413.
530. FOREST PRODUCTS INDUSTRIAL OPERATIONS ANALYSIS (2) Research methods, with emphasis on programming, simulation, and waiting line problems. Prerequisite: F.P. 435.
531. MECHANICAL BEHAVIOR OF WOOD (3) Time-dependent properties, theory of failure, rheologic properties, and theory of the mechanical behavior of wood and structural composites.
532. THEORY OF ADHESION (3) Theory of adhesion as it pertains to bonding of wood, paper-based laminates, fibers, and bonding of wood to dissimilar materials.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

**FORESTRY (FOR)**

- 403. DENDROLOGY (3)
  - 409. FOREST TREE FUNCTION AND FORM (2)
  - 412. FOREST TREE IMPROVEMENT (3)
  - 416. FOREST RECREATION (3)
  - 421. SILVICULTURE (3)
  - 436. FIELD PROBLEMS IN FOREST MANAGEMENT (6)
  - 440. FOREST ECONOMICS AND FINANCE (3)
  - 450. INTRODUCTION TO OPERATIONS RESEARCH (3)
  - 455. REMOTE SENSING AND SPATIAL DATA HANDLING (3)
  - 466. FOREST RESOURCE MANAGEMENT (3)
  - 470. WATERSHED MANAGEMENT (3)
  - 475. PRINCIPLES OF FOREST SOILS MANAGEMENT (3)
  - 480. POLICY AND ADMINISTRATION (3)
  - 495. FORESTRY INTERNSHIP (1-6)
  - 496. INDEPENDENT STUDIES (1-18)
  - 497. SPECIAL TOPICS (1-9)
508. FOREST ECOLOGY (3) The forest ecosystem, variations in space and time, classification, ordination techniques, dynamic aspects such as energy flow and nutrient cycling.

## FRENCH

512. **FOREST GENETICS (3)** Qualitative and quantitative genetic principles and research methods applied in tree breeding.
517. **FOREST MICROCLIMATOLOGY (3)** A quantitative treatment of climate near the ground, with special reference to the role of forests and terrain. Prerequisite: Phys. 202.
518. **HYDROLOGIC MEASUREMENTS (2)** Selection, installation, use, and maintenance of instrumentation used in hydrologic research and watershed management. Prerequisites: For. 470; For. 519 or 3 credits in hydrology.
519. **FOREST HYDROLOGY (3)** Influence of forest cover on the disposition of precipitation and the application of hydrologic principles and techniques to forest watersheds. Prerequisites: For. 308, C.E. 351.
520. **SNOW HYDROLOGY (2)** Role of snow and ice in the hydrologic cycle, with special emphasis on effects of forests and land use. Prerequisite: For. 470 or 3 credits of hydrology.
521. **ADVANCED SILVICULTURE (3)** Specific silvicultural practices for the establishment and manipulation of forest stands with respect to recent developments and research needs. Prerequisite: For. 421.
525. **FOREST LAND USE (3)** Concepts of supply and demand for forest lands and their allocation to alternative uses. Prerequisites: For. 466; or Geog. 405 and 3 credits in economics.
550. **MULTIVARIATE ANALYSIS IN FORESTRY RESEARCH (3)** Analysis and interpretation of research data involving several response variables. Includes computational considerations for large data sets.
555. **MULTISPECTRAL REMOTE SENSING (3)** Computer analysis of data from nonimaging remote sensors as applied to mapping of natural resources and land use. Prerequisites: Cmp.Sc. 101, For. 455.
560. **TIMBER MANAGEMENT (3)** Technical methods in the organization and control of the forest property for timber production.
575. **APPLICATIONS OF FOREST ECONOMICS AND FINANCE (3)** Survey of situations in forestry where business problems and particular circumstances of production, value, and costs are currently significant. Prerequisite: For. 440.
590. **COLLOQUIUM (1-3)**
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**
602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)**

NOTE: *See also Wildlife Management.*

## FRENCH (FR)

RICHARD L. FRAUTSCHI, *Head of the Department*  
316 Burrowes Building  
814-865-1492

**Degrees Conferred:** Ph.D., D.Ed., M.A., M.B.A./M.A. in French Studies, M.S. in Business Administration/M.A. in French Studies

### Senior Members of the Graduate Faculty

Gerard J. Brault, Ph.D. (Pennsylvania) *Professor of French*  
Richard L. Frautschi, Ph.D. (Harvard) *Professor of French*  
Thomas A. Hale, Ph.D. (Rochester) *Associate Professor of French and Comparative Literature*  
Alan E. Knight, Ph.D. (Yale) *Associate Professor of French*  
Glyn P. Norton, Ph.D. (Michigan) *Associate Professor of French*  
Patricia A. Ward, Ph.D. (Wisconsin) *Professor of French and Comparative Literature*

### Associate Members of the Graduate Faculty

Robert Ariew, Ph.D. (Illinois) *Assistant Professor of French*  
Jeannette Danielle Bragger, Ph.D. (California) *Assistant Professor of French*  
Michael C. Danahy, Ph.D. (Princeton) *Associate Professor of French*



Donka F. Farkas, Ph.D. (Chicago) Assistant Professor of French and Linguistics  
 John Lowe Logan, Ph.D. (Yale) Assistant Professor of French  
 Christiane P. Makward, Docteur es Lettres (Paris) Associate Professor of French

This program offers training in French language, literature, linguistics, and civilization.

### Admissions Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

The minimum requirement for admission to an advanced degree program will normally be 36 credits of postintermediate work in language and literature. Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. A brief tape recording of an original composition in French must be presented before admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

### Master's Degree Requirements

A candidate for the M.S. degree (minimum of 30 credits) may select a program of study emphasizing language proficiency as well as culture and literature. A reading knowledge of a second foreign language plus oral and written examinations are required. The candidate may submit either a thesis, for which 6 research credits are normally awarded, or a paper. The M.A. degree (or equivalent) is normally a prerequisite to doctoral candidacy.

The department, in cooperation with the College of Business Administration, offers concurrent master's degree programs in French Studies and in Business Administration to provide training in both business and French studies for students who plan careers in international business. The Master of Business Administration/M.A. in French Studies program is open to graduates of accredited colleges and universities. Candidates will first be admitted as students seeking the M.B.A. or seeking the M.A. in French. Assisted by graduate advisers in both programs, students will determine the appropriate entry courses in the second program, including an intensive summer language program, prior to official acceptance by both programs as concurrent degree candidates.

The M.B.A./M.A. in French Studies program consists of a minimum of 66 credits: 39 in M.B.A. courses and 27 in graduate French language and culture courses. Required courses in business will be taken in the following sequence: tool and theory courses (M.I.S. 531, Q.B.A. 510, Acctg. 511, Q.B.A. 511, B.A. 517, 533); functional courses (Mktg. 500, 510, Fin. 531); "capstone" courses (B.A. 555, 557, and I.B. 500). International business courses at the University of Nice /C.E.R.A.M./ may be substituted for B.A. 555. Required courses in French are language (minimum of 9 credits): Fr. 408, 507, 508, 510; culture and civilization (minimum of 9 credits): Fr. 530, 531, 595; electives (minimum of 9 graduate credits).

All concurrent degree candidates will prepare a paper in both French and English (no credits). A final oral examination may be recommended.

The M.S. in Business Administration/M.A. in French Studies permits specialized interests in an area of business administration as well as advanced proficiency in Francophone language and culture. A B.A. or B.S. degree with a minimum of 30 credits (or equivalent) in French and another 30 credits (or equivalent) in business administration/economics are prerequisites. Admission is contingent upon approval by the College of Business Administration and by the Department of French. The program consists of 54 graduate credits: 21-27 credits in business and 24-30 credits in French. Candidates will specialize in a major field of business administration. Required courses in French are Fr. 508, 510, 595, one graduate course in metropolitan literature, plus at least 9 elective graduate credits.

A master's thesis in both French and English is recommended. However, candidates may present a special paper (no credits) in both languages. A final oral examination will be scheduled.

Candidates in both concurrent degree programs are urged to spend one or more semesters of study at the University of Nice /C.E.R.A.M./ in work-study programs approved for Penn State students. Candidates should consult with their graduate advisers and the Office of Foreign Studies regarding application procedures.

### Doctoral Degree Requirements

The D.Ed. degree is structured for students preparing careers emphasizing teaching, curriculum design, and administration in secondary and postsecondary education. Of the 90 required graduate credits, a minimum of 60 (including M.A. credits) must be acquired in French courses and another 15 in the College of Education. A reading knowledge of a second foreign language, other than French, is also required. A thesis focusing on a pedagogical topic is selected and may be supervised by faculty in both French and education.

The Ph.D. degree prepares candidates for careers in teaching and research at the college level. A minimum of 66 credits (including M.A. credits) is required in graduate course work, 36 of which must be distributed in metropolitan literature. Candidates may specialize in French literature, linguistics, francophone literature, or, with special permission, interdisciplinary study in the humanities, social sciences, or fine arts. The communication and foreign language requirement for the Ph.D. degree may be satisfied by at least a reading knowledge of two foreign languages other than French.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

### FRENCH (FR)

\*1G. ELEMENTARY FRENCH FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees.

\*2G. ELEMENTARY FRENCH FOR GRADUATE STUDENTS (3) Continuation of Fr. 1G, with reading practice.

500. INTRODUCTION TO OLD FRENCH (3) Analysis of the phonology, morphology, and syntax of Old French based on early literary monuments. *Brault*

503. FRENCH PHONOLOGY (3) Articulatory and acoustic correlates of distinctive features; synchronic dialectology; phonology in generative grammar. *Farkas*

504. FRENCH MORPHOLOGY AND SYNTAX (3) Principles of segmentation and decomposition; tagmemics and transformation theory; morphophonemics. *Farkas*

505. SYNTAX AND SEMANTICS OF FRENCH (3) The course will examine the relationship between syntax and semantics based on French data. Prerequisite: Fr. 418.

507. COMPOSITION (3) Review of sentence and paragraph composition, with special emphasis on idiomatic structures. *Bragger*

508. FRENCH BUSINESS COMMUNICATIONS (3 per semester, maximum of 6) Written and oral elements of French commerce and industry. Prerequisite: Fr. 510. *Boisset*

510. STYLISTIQUE AVANCÉE (3) Study of rhetorical figures and expository style in prose and poetry through *dissertation* and *explication*.

511. READINGS IN OLD FRENCH (3 per semester, maximum of 6) A survey of French literature to 1300, focusing in alternate semesters on either the twelfth or the thirteenth century. *Brault*

512. LATE MEDIEVAL FRENCH LITERATURE (3) The nondramatic literary genres of the late Middle Ages, with reference to their cultural context and social function. *Knight*

516. THE SONG OF ROLAND (3) Seminar in the Old French *Chanson de Roland*, with emphasis on the problems of textual criticism and literary analysis. *Brault*

518. MEDIEVAL FRENCH DRAMA (3) The development of French drama from its liturgical origins to the flourishing comic theatre of the late Middle Ages. *Knight*

526. AGE OF RABELAIS (3) Notions of literary creativity in the context of early sixteenth-century French Humanism; readings from Rabelais, Marguerite de Navarre, Scève. *Norton*

528. AGE OF MONTAIGNE (3) Literary culture of Renaissance France in the context of social and political crisis; readings from Montaigne, DuBellay, Ronsard, and Sponde. *Norton*

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\*No graduate credit is given for this course.



529. SEMINAR IN RENAISSANCE LITERATURE (3 per semester, maximum of 6) Intensive study of various French Renaissance writers in relation to selected artistic issues of the period. *Norton*
530. LA FRANCE CONTEMPORAINE (3) A comprehensive cross-sectional view of French society and its institutions since World War II. *Bragger*
531. FRANCOPHONE CULTURE (3 per semester, maximum of 6) Concept of francophone; French minorities in Europe and North America; role of French language in Africa, Middle East, Far East. *Hale*
533. SEVENTEENTH-CENTURY PROSE AND POETRY (3) The development of classicism; its apogee and decline as seen in the works of major prose writers and poets. *Logan*
534. MOLIÈRE (3) The literary achievement of Molière, the comic playwright, director, actor, and founder of the Comédie Française. *Logan*
535. SEVENTEETH-CENTURY FRENCH TRAGEDY (3) The development and triumph of tragedy as a literary genre, with special emphasis on the achievement of Corneille and Racine. *Logan*
540. VOLTAIRE AND HIS CONTEMPORARIES (3) The artistic and philosophical evolution of Voltaire as seen in the tragedy, the philosophical tale, and poetry. *Frautschi*
541. ROUSSEAU AND HIS CONTEMPORARIES (3) Rousseau's rationalistic critique of civilization; his sentimental rehabilitation of the individual, family, state; Rousseau, precursor of romanticism. *Frautschi*
543. SEMINAR: STUDIES IN THE ENLIGHTENMENT (3 per semester, maximum of 6) Discourse and thematic analysis of selected works of French Enlightenment genres: essay, drama, fiction, poetry. *Frautschi*
561. FRENCH ROMANTICISM (3) The romantic movement in French literature, with emphasis upon its major exponents in prose and poetry. *Danahy*
563. FRENCH REALISM (3) The realistic movement in French literature, with emphasis upon its major exponents in prose and poetry. *Danahy*
565. SEMINAR: NINETEENTH-CENTURY STUDIES (1-6) Various nineteenth-century French writers considered in relation to selected esthetic and cultural problems raised during the period. *Danahy and Ward*
569. MASTERS OF TWENTIETH-CENTURY FRENCH LITERATURE (3-6) Major literary figures of contemporary French literature. *Makward*
570. MODERN FRENCH POETRY (3 per semester, maximum of 6) Historical overview through readings from major poets since Baudelaire; introduction to basic concepts in criticism of poetry.
571. FRENCH LITERARY CRITICISM FROM SAINTE-BEUVE TO PRESENT (3) Evolution of French literary criticism from Sainte-Beuve, the "father" of modern literary criticism, to contemporary critics.
572. SEMINAR: TWENTIETH-CENTURY FRENCH LITERATURE (3 per semester, maximum of 6) Specialized consideration of contemporary writers; for advanced students.
581. THEORY AND TECHNIQUES OF TEACHING FRENCH (1-6)
595. ANALYSIS OF FRENCH CIVILIZATION (3-6) French cultural aspects, other than language and literature, conducted in French with the collaboration of specialists outside the French department.
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## FUEL SCIENCE (F SC)

ROBERT G. JENKINS, *In Charge of Graduate Programs in Fuel Science*  
320 Steidle Building  
814-865-6511

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Leonard G. Austin, Ph.D. (Penn State) *Professor of Fuels and Mineral Engineering*  
Peter H. Given, Ph.D. (Oxford) *Professor of Fuel Science*  
Howard B. Palmer, Ph.D. (Wisconsin) *Professor of Energy Science*  
Francis J. Vastola, Ph.D. (Penn State) *Professor of Fuel Science*  
Philip L. Walker, Jr., Ph.D. (Penn State) *Evan Pugh Professor Emeritus of Materials Science*

### Associate Members of the Graduate Faculty

Robert G. Jenkins, Ph.D. (Leeds) *Associate Professor of Fuel Science*  
James J. Reuther, Ph.D. (Penn State) *Assistant Professor of Fuel Science*  
Alan W. Scaroni, Ph.D. (Penn State) *Assistant Professor of Fuel Science*

Graduate work in fuel science provides advanced professional knowledge and research opportunities in the characteristics and utilization of fuels, including their conversion to energy, to other fuels, or to other materials.

Well-instrumented research facilities are available for investigation of the chemical and physical characteristics of coals, fundamentals of coal gasification and liquefaction, flame dynamics in practical combustion systems, industrial fuel efficiency, chemistry and physics of basic combustion phenomena, chemical kinetics of fast gaseous reactions, formation and removal of polluting species in combustion processes, physics and chemistry of carbonaceous solids, organic geochemistry of plant-derived sediments, modeling of energy systems, and electrochemical energy conversion. Students can plan a wide variety of programs of study to suit individual needs; coherent interdisciplinary programs are encouraged.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Applications will be accepted from persons having degrees in the basic or applied physical sciences or in engineering. Students with a 2.75 junior-senior average normally will be considered for admission. Exceptions may be made for students with special abilities, interests, or backgrounds, such as extensive industrial experience in fuels or combustion.

### Degree Requirements

The nonthesis option is available for the M.S. degree.

Competency in a foreign language is not required for the Ph.D. degree. Candidates are expected to demonstrate high proficiency in both written and spoken English.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## FUEL SCIENCE (F SC)

- 410. FUEL SCIENCE (3)
- 421. FLAMES (3) *Palmer*
- 422. COMBUSTION ENGINEERING (3) *Reuther or Scaroni*
- 424. ENERGY AND FUELS IN TECHNOLOGICAL PERSPECTIVE (3) *Vastola*
- 430. AIR POLLUTANTS FROM COMBUSTION SOURCES (3) *Reuther*
- 431. THE CHEMISTRY OF FUELS (3) *Given*



496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

501. STRUCTURE AND PROPERTIES OF COALS (3) Modern developments in coal structural studies and relationships between structure and properties of coal and coal-derived solids. Prerequisite: F.Sc.

431. *Jenkins*

502. COAL CONVERSION PROCESSES (3) Review of current scientific and technological developments in coal conversion to gaseous and liquid fuels. Prerequisite: F.Sc. 431. *Jenkins*

506. CARBON REACTIONS (3) Current approaches to heterogeneous reactions in combustion and gasification of carbonaceous solids, including those derived from coal and petroleum sources. Prerequisite: Chem. 452.

512. HIGH-TEMPERATURE KINETICS AND FLAME PROPAGATION (3) Laminar and turbulent premixed and diffusion flames; gaseous detonations; rate processes in high-temperature gases. Prerequisite: F.Sc. 421. *Palmer*

520. THERMODYNAMICS AND KINETICS OF FUEL EFFICIENCY (3) Thermodynamics and kinetic constraints on efficiencies of thermal systems; efficiency ratios; furnace analysis; radiation in furnaces, applications and examples. Prerequisite: study of thermodynamics at the upperclass or graduate level. *Reuther*

522. FLAME DYNAMICS IN COMBUSTORS (3) Mixing and reaction in combustion chambers; combustor analysis; residence time distributions; perfectly and well-stirred combustors; models and experiments. *Reuther*

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

NOTE: Courses in the use of X-ray diffraction, electron microscopy, spectroscopy, and electronic instrumentation in fuel science studies are listed under Materials Science.

## GENETICS (GENET)

GERALD E. McCLEARN, *Chairman of the Graduate Program in Genetics*  
S-211 Henderson Human Development Building  
814-863-2032

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

John E. Ayers, Ph.D. (Penn State) *Professor of Plant Pathology*  
Cheston M. Berlin, M.D. (Harvard) *Professor of Pediatrics and Pharmacology*  
Edward G. Buss, Ph.D. (Purdue) *Professor of Poultry Science*  
Richard W. Cleveland, Ph.D. (California) *Professor of Plant Breeding*  
Richard Craig, Ph.D. (Penn State) *Associate Professor of Plant Breeding*  
Eugene A. Davidson, Ph.D. (Columbia) *Professor of Biological Chemistry*  
Reginald A. Deering, Ph.D. (Yale) *Professor of Biophysics*  
John J. Docherty, Ph.D. (Arizona) *Associate Professor of Microbiology*  
Robert B. Eckhardt, Ph.D. (Michigan) *Associate Professor of Anthropology*  
Paul J. Fritz, Ph.D. (Auburn) *Associate Professor of Pharmacology*  
Henry D. Gerhold, Ph.D. (Yale) *Professor of Forest Genetics*  
Kenneth Goodwin, Ph.D. (Cornell) *Professor of Poultry Science*  
Paul Grun, Ph.D. (Cornell) *Professor of Cytology and Cytogenetics*  
George L. Hargrove, Ph.D. (North Carolina State) *Associate Professor of Dairy Science*  
Charles W. Hill, Jr., Ph.D. (Cornell) *Adjunct Professor of Plant Breeding*  
R. R. Hill, Ph.D. (Cornell) *Adjunct Professor of Plant Breeding*  
Edward E. Hunt, Jr., Ph.D. (Harvard) *Professor of Anthropology and Health Education*  
Samson T. Jacob, Ph.D. (Agra) *Professor of Pharmacology*  
Melvin W. Johnson, Ph.D. (Wisconsin) *Associate Professor of Plant Breeding*  
Marshall B. Jones, Ph.D. (California) *Professor of Behavioral Science*  
C. Max Lang, D.V.M. (Illinois) *Professor of Comparative Medicine*  
David R. MacKenzie, Ph.D. (Penn State) *Assistant Professor of Plant Pathology*

## GENETICS

Harold G. Marshall, Ph.D. (Minnesota) *Adjunct Professor of Plant Breeding*  
Gerald E. McClearn, Ph.D. (Wisconsin) *Professor of Human Development*  
Bryce Munger, M.D. (Washington) *Professor of Anatomy*  
Nicholas M. Nelson, M.D. (Cornell) *Professor of Pediatrics*  
Richard R. Nelson, Ph.D. (Minnesota) *Evan Pugh Professor of Plant Pathology*  
Stanley R. Person, Ph.D. (Yale) *Professor of Biophysics*  
Fred Rapp, Ph.D. (Southern California) *Evan Pugh Professor of Microbiology*  
Marvin L. Risius, Ph.D. (Cornell) *Professor of Plant Breeding*  
Cara-Lynne Schengrund, Ph.D. (Seton Hall) *Associate Professor of Biological Chemistry*  
Jack C. Shannon, Ph.D. (Illinois) *Professor of Horticultural Physiology*  
John S. Shenk, Ph.D. (Michigan State) *Professor of Plant Breeding*  
Ross Shiman, Ph.D. (California) *Associate Professor of Biological Chemistry*  
Wallace C. Snipes, Ph.D. (Duke) *Professor of Biophysics*  
James L. Starling, Ph.D. (Penn State) *Professor of Agronomy*  
Kim C. Steiner, Ph.D. (Michigan State) *Associate Professor of Forest Genetics*  
S. Edward Stevens, Jr., Ph.D. (Texas) *Assistant Professor of Microbiology*  
William D. Taylor, Ph.D. (Manchester) *Professor of Biophysics*  
Mary J. Tevethia, Ph.D. (Michigan State) *Associate Professor of Microbiology*  
C. Dale Therrien, Ph.D. (Texas) *Associate Professor of Biology*  
Paul W. Todd, Ph.D. (California) *Professor of Biophysics*  
Elliot S. Vesell, M.D. (Harvard) *Evan Pugh Professor of Pharmacology, Genetics, and Medicine*  
Judith Weisz, M.B., B.Chir. (London) *Professor of Obstetrics and Gynecology*  
Lowell L. Wilson, Ph.D. (South Dakota State) *Professor of Animal Science*  
James E. Wright, Jr., Ph.D. (Cornell) *Professor of Genetics*  
Ian S. Zagon, Ph.D. (Colorado) *Assistant Professor of Anatomy*  
Leonard N. Zimmerman, Ph.D. (Cornell) *Professor of Bacteriology*

### **Associate Members of the Graduate Faculty**

Clyde C. Berg, Ph.D. (Washington State) *Adjunct Associate Professor of Agronomy*  
Charles D. Boyer, Ph.D. (Penn State) *Associate Professor of Plant Breeding and Genetics*  
Frederick G. Ferguson, Ph.D. (Pennsylvania) *Professor of Veterinary Science*  
Terry Foch, Ph.D. (Colorado) *Assistant Professor of Human Development*  
Ross C. Hardison, Ph.D. (Iowa) *Assistant Professor of Biochemistry*  
Anita K. Hopper, Ph.D. (Illinois) *Associate Professor of Biological Chemistry*  
James E. Hopper, Ph.D. (Wisconsin) *Associate Professor of Biological Chemistry*  
Roger L. Ladda, M.D. (Chicago) *Assistant Professor of Pediatrics*  
Dai K. Liu, Ph.D. (Alabama) *Assistant Professor of Pharmacology*  
Andrea M. Mastro, Ph.D. (Penn State) *Assistant Professor of Microbiology*  
William J. McCarthy, Ph.D. (New York) *Assistant Professor of Plant Pathology*  
Robert M. Petters, Ph.D. (North Carolina State) *Assistant Professor of Biology*  
Ronald D. Porter, Ph.D. (Duke) *Assistant Professor of Microbiology and Cell Biology*  
Charles P. Romaine, Ph.D. (Cornell) *Assistant Professor of Plant Pathology*  
Kathleen M. Rose, Ph.D. (Penn State) *Assistant Professor of Pharmacology*  
Robert A. Schlegel, Ph.D. (Harvard) *Associate Professor of Molecular and Cell Biology*  
Steven J. Smith, Ph.D. (Baylor) *Assistant Professor of Pharmacology*  
Chen-Pei David Tu, Ph.D. (Cornell) *Assistant Professor of Biochemistry*  
James B. Turpen, Ph.D. (Tulane) *Assistant Professor of Biology*  
William J. White, M.S. (Penn State) *Assistant Professor of Comparative Medicine*

The intercollege program in Genetics includes faculty of eighteen departments in the Colleges of Agriculture, Human Development, the Liberal Arts, Medicine, and Science. Each student becomes associated with the adviser's department, which may provide financial support, research facilities, and office space. Applicants are encouraged to explore opportunities by contacting faculty who may be prospective advisers.

Fields available for study and research include molecular, biochemical, physiological, cellular, behavioral, developmental, pharmacological, population, and evolutionary genetics; also applications in recombinant DNA technology, genetic engineering, breeding plants or animals, and genetic counseling of humans. Organisms which are subjects of research include viruses, bacteria, fungi, insects, fish, birds, rodents, trees, agricultural plants, domestic animals, and humans. Many types of modern equipment, laboratories, field installations, and collections of various organisms are available.

### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for*



*graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

All application materials should be submitted by January 31 for the best chance of admission and financial aid. Applicants should have a cumulative average of at least 3.00 and appropriate courses in biology, including genetics, organic or biochemistry, statistics, other sciences, and communications. The application should include three letters of reference and a statement describing and explaining interests in genetics, types of organism and research preferred, and goals during and after graduate studies. An M.S. degree is the normal precursor to the Ph.D. degree. The M.S. may be bypassed if evidence of suitable research experience is presented, such as a refereed publication.

### **Master's Degree Requirements**

A committee appointed for each student, with the approval of the program chairman, determines specific courses, communication skills, and research acceptable for satisfying M.S. degree requirements. Course requirements include 3 credits in statistics, 3 credits per year in genetics colloquium (Genet. 590 or Pharm. 515), and 12 credits selected from the following courses: Agro. 411, 509, 510, 511; An.Sc. 422; Bioch. 514; B.Chem. 503; Biol. 422, 426, 427, 428, 429, 465, 533; M.C.B. 430, 450, 460, 475, 589; C.Med. 503; For. 412, 512; Hort. 407, 444; Micrb. 505; Micro. 553, 556; Ped. 525, 526; Pharm. 515, 540; P.Path. 543.

### **Doctoral Degree Requirements**

The student's Ph.D. committee, appointed after a written and oral candidacy examination is passed, determines specific requirements for courses and research, and administers the comprehensive and final examinations. A Ph.D. major in Genetics requires 15 credits in genetics courses listed above, or equivalent transfer courses, plus 3 credits per year in genetics colloquium; a Ph.D. minor in Genetics requires 12 credits in genetics courses, plus 3 credits in statistics and 3 credits of genetics colloquium. The requirement in communication and foreign language skills is the same as that of the thesis adviser's department or program.

### **Other Relevant Information**

When an applicant has been approved for admission by the faculty, an adviser is selected from those who indicate they are available, by mutual consent of the faculty member and the student; financial support is commonly a consideration at this time. The adviser is the chief source of guidance, advice, and liaison with the Genetics program and the associated department.

### **Student Aids**

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin. In most participating departments, Genetics applicants are eligible for departmental teaching or research assistantships, and other assistantships supported by grant funds of individual faculty who make these award decisions.

Applicants with a grade-point average above 3.60 and superior GRE scores are encouraged to request fellowship applications from the Graduate School before January 31.

## **GENETICS (GENET)**

590. COLLOQUIUM (1-3)

## **GEOGRAPHY (GEOG)**

C. GREGORY KNIGHT, *Head of the Department*  
302 Walker Building  
814-865-3433

**Degrees Conferred:** Ph.D., M.S.

### **Senior Members of the Graduate Faculty**

Ronald F. Abler, Ph.D. (Minnesota) *Professor of Geography*  
Roger M. Downs, Ph.D. (Bristol) *Professor of Geography*  
Rodney A. Erickson, Ph.D. (Washington) *Associate Professor of Geography*  
Peter R. Gould, Ph.D. (Northwestern) *Professor of Geography*

## GEOGRAPHY

C. Gregory Knight, Ph.D. (Minnesota) *Professor of Geography*  
Peirce F. Lewis, Ph.D. (Michigan) *Professor of Geography*  
E. Willard Miller, Ph.D. (Ohio State) *Professor Emeritus of Geography*  
Allan L. Rodgers, Ph.D. (Wisconsin) *Professor of Geography*  
Paul D. Simkins, Ph.D. (Wisconsin) *Professor of Geography*  
Frederick L. Wernstedt, Ph.D. (U.C.L.A.) *Professor of Geography*  
Anthony V. Williams, Ph.D. (Michigan State) *Associate Professor of Geography*  
Lakshman S. Yapa, Ph.D. (Syracuse) *Associate Professor of Geography*  
Wilbur Zelinsky, Ph.D. (California, Berkeley) *Professor of Geography*

### **Associate Member of the Graduate Faculty**

J. Ronald Eyton, Ph.D. (Illinois) *Associate Professor of Geography*

The faculty encourages graduate students to arrange courses of study appropriate to their individual needs and aspirations. Programs in Geography may be directed toward a career in public service, teaching and research, private industry, or one of the many other vocational opportunities open to geographers.

Students may concentrate their study on topics that fall within the special skills and interests of the faculty. Current specialties include the American landscape; behavioral geography; communications systems; the cultural and human geography of Africa, Anglo-America, Southeast Asia, and the U.S.S.R.; geographical analysis, including cartography, computer mapping, mathematical modeling, methods of geographical analysis, remote sensing, and statistical techniques; geography of the developing world; geographical theory; environmental management; industrial location; planning and regional economic development; political geography; population problems; and urban geography.

The master's program is broadly based. It is designed to provide beginning graduate students with basic training in systematic fields, geographical theory, and research techniques. Study at the doctoral level is more specialized. After admission to candidacy, doctoral students select two fields of concentration. Students may specialize in the geography of a region only if one of the faculty on their doctoral committee has research experience in that region.

### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in the program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Students with a 3.00 junior-senior average and with appropriate course work in geography or a related discipline will be considered for admission to the M.S. program. Applicants with master's degrees from high-quality graduate programs in geography will be considered for admission to the doctoral program. The best-qualified applicants will be admitted up to the number of places that are available for new students. All students must have or must acquire competence in cartography and statistical analysis.

Baccalaureate students must earn a master's degree before they will be considered for admission to the doctoral program.

### **Master's Degree Requirements**

The M.S. degree may be earned by completing a thesis or two papers. If the two-paper option is elected, the candidate must earn 35 credits of graduate-level work. The master's papers are usually expanded versions of course or seminar papers that are of sufficiently high quality that they can be submitted to scholarly journals. At least one of the papers offered to fulfill the M.S. papers requirement must have been written in connection with a departmental course or seminar.

All M.S. students are required to enroll in Geog. 500 (Introduction to Geographic Research) during their first year of residence. All candidates for the M.S. must take and pass an oral qualifying examination administered by three members of the graduate faculty before completing the M.S.

### **Doctoral Degree Requirements**

The Graduate School's communication and foreign language requirement for the Ph.D. degree shall be satisfied in a manner approved by the candidate's doctoral committee.

All doctoral students are required to enroll in Geog. 500 (Introduction to Geographic Research) during their first year of residence.



**Other Relevant Information**

Penn State's graduate program in Geography attempts to meet the needs of incoming students by working with them to design programs tailored to their specific interests and needs. Thus there are few formal requirements and a maximum of opportunities for students to pursue their own interests under the guidance of the faculty. Each student's work is supervised by his or her academic adviser and by a committee consisting of two additional members of the graduate faculty for M.S. students and three or four additional members for doctoral students.

**Student Aids**

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

**GEOGRAPHY (GEOG)**

401. HISTORICAL GEOGRAPHY OF NORTH AMERICA (3) *Lewis or Zelinsky*
402. CULTURAL AND ANTHROPOGEOGRAPHY (3) *Zelinsky*
404. THE AMERICAN SCENE: PART II (3) *Lewis*
405. GEOGRAPHY OF POPULATION (3) *Simkins or Zelinsky*
406. HUMAN USE OF ENVIRONMENT (3) *Knight*
410. CARTOGRAPHY — MAP DESIGN AND CONSTRUCTION (3) *Abler*
411. ADVANCED CARTOGRAPHY (3) *Abler*
412. THE GEOGRAPHY OF THE FUTURE (3) *Abler*
413. BEHAVIORAL APPROACHES TO GEOGRAPHY (3) *Downs*
416. LOW-ENERGY LIVING (3) *Knight*
420. METROPOLITAN ANALYSIS (3) *Erickson*
427. GEOGRAPHY OF THE SOVIET UNION (3) *Rodgers*
433. REGIONAL CLIMATOLOGY (3) *Wernstedt*
434. REGIONAL PHYSIOGRAPHY (3) *Lewis*
440. GEOGRAPHY OF MIDDLE AMERICA (3) *Simkins*
441. GEOGRAPHY OF SOUTH AMERICA (3) *Simkins*
442. REGIONAL SYSTEMS IN EUROPE (3) *Miller*
443. GEOGRAPHY OF THE ORIENT (3) *Rodgers*
444. AFRICAN RESOURCES AND DEVELOPMENT (3) *Knight*
445. GEOGRAPHY OF SOUTHERN ASIA (3) *Wernstedt*
450. DEVELOPMENT OF GEOGRAPHIC THOUGHT (3) *Abler*
451. MAP INTERPRETATION (3) *Lewis*
452. IMAGE ANALYSIS I (3) *Eyton*
453. IMAGE ANALYSIS II (3) *Eyton*
454. SPATIAL ANALYSIS I (3) *Gould or Williams or Yapa*
455. SPATIAL ANALYSIS II (3) *Gould or Williams or Yapa*
457. GEOGRAPHIC DATA SYSTEMS (3) *Williams*
458. COMPUTER MAPPING (3) *Williams*
460. POLITICAL GEOGRAPHY (3) *Williams*
470. INDUSTRIAL LOCATION AND DEVELOPMENT (3) *Rodgers*
475. GEOGRAPHY OF COMMUNICATIONS SYSTEMS (3) *Abler*
495. INTERNSHIP (1-13)
496. INDEPENDENT STUDIES (1-18)
497. SPECIAL TOPICS (1-9)
  
500. INTRODUCTION TO GEOGRAPHIC RESEARCH (1-3)
502. REGIONAL THEORY (3) Taxonomic methods of uniform-functional regionalization; canonical linkages; intraregional relationships; Wilson models of macrocanonical ensembles.
504. PHYSICAL GEOGRAPHY SEMINAR (3-12) The examination of current problems and theories in physical geography through critical discussion of the literature and student research.
505. ECONOMIC GEOGRAPHY SEMINAR (3-12) The examination of current problems and theories in economic geography through critical discussion of the literature and original student research.
508. CULTURAL GEOGRAPHY SEMINAR (3-6) The exploration of current problems and theory in cultural geography through critical discussion of the literature and original student research.

## GEOSCIENCES

509. POPULATION GEOGRAPHY SEMINAR (3) Selected problems in population geography, with emphasis on analysis and presentation of data. Prerequisite: Geog. 405.
510. ANALYTIC CARTOGRAPHY (3) Computer graphics, geographical matrix operations, response functions, sampling resolution, quantization, map generalization, pattern recognition, generalized spatial partitionings, and map projections. Prerequisites: Geog. 454, 455.
517. GEOGRAPHIC MODELING (1) Spatial modeling, mapping, and transformations of elementary geographic problems.
525. FIELD SEMINAR IN GEOGRAPHY (3) Intensive study of the morphology and origins of vernacular human landscapes in eastern United States and Canada. Two-week field trip. Prerequisites: Geog. 2, 102, 404.
590. COLLOQUIUM (1-3),
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## GEOSCIENCES (GEOSC)

C. WAYNE BURNHAM, *Head of the Department*  
503 Deike Building  
814-865-6711

There are three graduate degree programs to which a student may be admitted: Geochemistry and Mineralogy, Geology, and Geophysics. Transfer from one of these majors to another is possible, provided the basic admission requirements of the program into which the student is transferring are met and the student is accepted into that program.

A wide range of faculty interests and exceptional laboratory facilities provide an extensive variety of areas of specialization in which students may choose their course work and research topics. In addition to a variety of computing facilities, students have access to laboratories for research on the petrography and petrology of igneous, metamorphic, and sedimentary rocks, including coal and organic sediments; complete palynological processing and microscopy facilities; rock preparation and rock mechanics laboratories; high-temperature and high-pressure/high-temperature equipment for dry or hydrothermal geochemical experiments and solid-state geophysical measurements; mass spectrometers and ancillary equipment for isotope analysis; a seismic observatory, ultrasonic model and paleomagnetism laboratories, and field equipment for seismic, electrical, magnetic, and gravity surveys; facilities and data for remote sensing of earth resources; laboratories and field facilities for the study of the hydrogeology and geochemistry of natural waters; an X-ray laboratory for single-crystal and powder methods at low and high temperatures; and coastal marine laboratories in Virginia. The department and the Mineral Constitution Laboratories are equipped for both classical methods of chemical analysis and modern instrumental methods, such as atomic absorption, emission and absorption spectroscopy, electron microscopy and scanning electron microscopy, and electron microprobe analysis. The department also maintains a predoctoral research program in cooperation with the Geophysical Laboratory of the Carnegie Institution in Washington.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

For admission, applicants generally are expected to have a bachelor's degree in some branch of the natural or physical sciences, engineering, or mathematics. An applicant also is expected to have completed standard introductory courses in geosciences, chemistry, physics, and mathematics through integral calculus, plus 15 credits of intermediate-level work in one or a combination of these subjects. Greater than minimal preparation within these limits may be required in chemistry and mineralogy for



the Geochemistry and Mineralogy major; in geology and biology for the Geology major; and in mathematics and physics for the Geophysics major. Applicants who have taken somewhat less than the indicated minimum in these subjects may be admitted but must make up their deficiencies concurrently with their graduate studies. Students with special backgrounds, abilities, and interests whose undergraduate grade-point average in courses pertinent to geosciences is below a 3.00 will be considered for admission only when there are strong indications that a 3.00 average can be maintained at the graduate level.

Students without an M.S. degree generally are admitted to a master's program; however, a student may work toward a Ph.D. degree without first earning a master's degree. If this option is desired, the student must arrange the scheduling of a candidacy evaluation no later than the end of the second semester of residence at Penn State. The petition to bypass the M.S. degree must be approved by the program chairman and the student's research and academic adviser(s).

Students with an M.S. degree are generally admitted to a Ph.D. program, except where it appears advisable to the admissions committee that the student receive an additional M.S. degree in the particular program to which admission is sought. The applicant will be informed of the decision prior to admission.

### Faculty Advisers

Upon arrival students will be advised initially either by the program chairman or someone designated by him or her. Before the end of the first academic year of residence in the department, the student is expected to develop specific academic and research interests so that an appropriate permanent academic and research adviser may be chosen. The academic adviser and the research adviser are usually the same person, except when the research adviser is not a member of the faculty of the student's graduate program. In such a case, a faculty member in the student's graduate program will serve as the academic adviser. Upon request from a student to the program chairman, or for other reasons, it is possible to change advisers if the reassignment best serves the interests of the student and the department.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## GEOSCIENCES (GEOSC)

- 401. GEOLOGIC PERSPECTIVES OF INDUSTRIAL ACTIVITIES (2) *Dachille*
- 402. (Meteo. 476) NATURAL DISASTERS SEMINAR (2)
- 403. GEOLOGICAL ASPECTS OF ENVIRONMENTAL PROBLEMS (3) *Dachille*
- 404. GEOLOGY OF THE SOLAR SYSTEM (3) *Dachille*
- 408. (Mat.Sc. 408) X-RAY DIFFRACTION (3)
- 409. CRYSTALLOGRAPHY AND OPTICAL CRYSTALLOGRAPHY (3) *Smith and Thornton*
- 411. (Mat.Sc. 411) INSTRUMENTAL TECHNIQUES APPLIED TO MATERIALS AND MINERAL SCIENCES PROBLEMS (1-8)
  - Unit A. X-RAY DIFFRACTION
  - Unit B. TRANSMISSION ELECTRON MICROSCOPY
  - Unit C. SPECTROSCOPY
  - Unit D. ELECTRON MICROPROBE ANALYSIS
  - Unit E. SCANNING ELECTRON MICROSCOPY
  - Unit F. ABSORPTION SPECTROSCOPY
  - Unit G. ION BEAM TECHNIQUES
  - Unit I. ELECTRON SPECTROSCOPY FOR CHEMICAL ANALYSIS AND AUGER ELECTRON SPECTROSCOPY
- 415. GEOCHEMISTRY (3)
- 416. STABLE AND RADIOACTIVE ISOTOPES IN GEOSCIENCES: INTRODUCTION (3) *Ohmoto and Deines*
- 419. INTRODUCTION TO ORGANIC GEOCHEMISTRY (3) *Given*
- 420. (Biol. 420) PALEOBOTANY (3) *Spackman*
- 421. INTRODUCTION TO COAL PETROLOGY (3) *Davis*
- 422. COAL MEASURE GEOLOGY (3) *Davis*
- 423. (Biol. 423) INTRODUCTORY PALYNOLOGY (3) *Traverse*
- 425. FOSSILS (3) *Cuffey*
- 426. PALEOECOLOGY (3) *Cuffey*
- 427. (Biol. 427) EVOLUTION (3) *Cuffey and Traverse*

## GEOCHEMISTRY AND MINERALOGY

- 430. PETROLOGY (3)
- 434. VOLCANOLOGY (3) *Thornton*
- 438. BIOGENIC SEDIMENTATION (3) *Guber*
- \*439. STRATIGRAPHY (3) *Williams*
- 440. MARINE GEOLOGY (3) *Schmalz*
- 442. EVOLUTION OF COASTLINES (3)
- 445. COASTAL GEOLOGY (4) *Guber, Schmalz, and Williams*
- 451. ECONOMIC GEOLOGY (3) *Gold and Rose*
- 452. INTRODUCTION TO HYDROGEOLOGY (3) *Parizek*
- 454. GEOLOGY OF OIL AND GAS (3)-*Scholten*
- 457. GEOCHEMICAL EXPLORATION (3) *Rose*
- 461. GEOLOGY OF NORTH AMERICA (3) *Wright*
- \*462. DRAINAGE BASIN ANALYSIS (3)
- 465. STRUCTURAL GEOLOGY (3) *Gold*
- 466. MECHANICS OF GEOLOGICAL MATERIALS (3) *Voight*
- \*470. INTRODUCTION TO FIELD GEOLOGY (3) *Gold and Wright*
- \*471. FIELD STUDIES IN NORTH AMERICA (3)
- 472. FIELD GEOLOGY (7-8)
- 473. TOPOGRAPHIC MAPS AND AERIAL PHOTOGRAPHS (1)
- 482. GEOPHYSICAL WELL LOGGING (3)
- 484. GEOPHYSICAL SURVEYING (3) *Lavin*
- 485. APPLIED SEISMOLOGY (4)
- 486. POTENTIAL FIELDS (4) *Lavin*
- 487. ANALYSIS OF TIME SERIES (3) *Lavin*
- 488. THEORETICAL AND NUMERICAL METHODS IN GEOPHYSICS (3) *Alexander*
- 489. DYNAMICS OF THE EARTH (3) *Graham and Martin*
- 490. GEOLOGICAL SCIENCES SEMINAR (1-6 per semester)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## GEOCHEMISTRY AND MINERALOGY (G M)

DERRILL M. KERRICK, *In Charge of Graduate Programs in Geochemistry and Mineralogy*  
204 Deike Building  
814-863-0633

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Hubert L. Barnes, Ph.D. (Columbia) *Professor of Geochemistry*  
C. Wayne Burnham, Ph.D. (Cal. Tech.) *Professor of Geochemistry*  
Frank Dacheille, Ph.D. (Penn State) *Professor of Geochemistry*  
Peter Deines, Ph.D. (Penn State) *Professor of Geochemistry*  
David H. Eggler, Ph.D. (Colorado) *Associate Professor of Petrology*  
Derrill M. Kerrick, Ph.D. (Berkeley) *Professor of Petrology*  
Antonio C. Lasaga, Ph.D. (Harvard) *Associate Professor of Geochemistry*  
Arnulf Muan, Ph.D. (Penn State) *Professor of Mineral Sciences*  
Hiroshi Ohmoto, Ph.D. (Princeton) *Professor of Geochemistry*  
Arthur W. Rose, Ph.D. (Cal. Tech.) *Professor of Geochemistry*  
Rustum Roy, Ph.D. (Penn State) *Professor of the Solid State*  
Deane K. Smith, Ph.D. (Minnesota) *Professor of Mineralogy*  
Charles P. Thornton, Ph.D. (Yale) *Professor of Petrology*  
William B. White, Ph.D. (Penn State) *Professor of Geochemistry*

### Associate Member of the Graduate Faculty

Norman H. Suhr, M.S. (Chicago) *Associate Professor of Geochemistry*

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\*This course includes from one to several field trips for which an additional charge will be made.



A general description of the Department of Geosciences is given on page 204. Areas of specialization in the Geochemistry program include phase equilibria; element distribution and affiliations; isotope geochemistry; geochemical exploration; cosmochemistry; high-temperature and high-pressure geochemistry; ore-forming processes; igneous, sedimentary, and metamorphic petrology; experimental petrology and mineralogy; crystallography; crystal chemistry; X-ray mineralogy; clay mineralogy; and ore mineralogy.

### Master's Degree Requirements

All incoming students to the program take a background examination prior to registration to aid in effective advising and structuring of a suitable course program for individual students. Specific course requirements for individual students are established at this time.

A candidate for the M.S. degree may, after consultation with his or her adviser, elect to take either the thesis or the nonthesis option. There is no distinction between these options with regard to level or quality of the research required; the thesis or written report must be defended in an oral examination.

### Doctoral Degree Requirements

All graduate students in the Geochemistry and Mineralogy program who wish to be admitted to Ph.D. candidacy must take a candidacy examination. With the approval of his or her adviser, a student may petition to combine the defense of the M.S. thesis or paper and the Ph.D. candidacy evaluation into one oral examination.

The comprehensive examination in the Geochemistry and Mineralogy program consists of both written and oral portions. The written examination is six to eight hours in duration and covers the areas of geochemistry, mineralogy, petrology, and general geosciences. The oral examination, which usually lasts three hours, probes in depth the knowledge in the areas of the student's specialization.

The Ph.D. foreign language requirements may be met by fulfilling any one of the following criteria: (1) obtain a minimum average grade of 2.50 in two 3-credit courses in each of two languages taken at any accredited college, or obtain a minimum grade of B in the second course in both languages; (2) pass a lower-level reading proficiency examination in each of two languages, administered by the foreign language departments at any accredited college; (3) obtain a minimum average grade of 2.50 in a 12-credit sequence of courses in one language taken at any accredited college, or obtain a minimum grade of B in the last course in such a sequence; (4) pass a higher-level reading proficiency examination in one language, administered by the Department of Geosciences; (5) fulfill option 1 for one language and option 2 for a second language; or (6) fulfill option 1 or option 2 for one language and pass one of the graduate foreign language seminars offered by the Department of Geosciences.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## GEOCHEMISTRY AND MINERALOGY (G M)

501. RESEARCH FRONTIERS SEMINAR (1) Current research problems and activities in geochemistry and mineralogy. *Staff*

503. (Mat.Sc. 503) KINETICS OF MATERIALS PROCESSES (3) Introduction to application of transition state theory and mass transfer to the kinetics of materials and mineral processes. Prerequisites: Chem. 451; G.M. 521 or Mat.Sc. 501. *Lasaga*

512. (Mat.Sc. 512) PRINCIPLES OF CRYSTAL CHEMISTRY (3) Relation of structure to ionic size and nature; influence of pressure and temperature on structure; chemical-structural defects, crystalline solutions, phase-transitions. *Roy*

\*515. ORE PETROLOGY (3) Optical and hardness measurements and phase equilibria as used in identification and interpretation of textures of ore minerals. *Barnes*

518. STABLE ISOTOPE GEOCHEMISTRY (3) Theory of isotope fractionation mechanisms; its application to a wide range of problems in the earth and planetary sciences. *Deines*

520. PHASE EQUILIBRIA (2-3) Thermodynamic and geometrical analysis of phase equilibria in oxide and mineral systems at atmospheric and elevated pressures. *Eggler and Muan*

\*Offered alternate years.

521. MINERAL EQUILIBRIA (3) A thermodynamic treatment of minerals and their reactions under geochemically important conditions of temperature and pressure. Prerequisite: Chem. 451. *Lasaga*
522. GEOCHEMISTRY OF AQUEOUS SYSTEMS (2-3) Ionic and molecular equilibria related to stabilities and solubilities of minerals, with applications to ground water, sea water, and hydrothermal fluids. Prerequisites: Chem. 451-452. *Barnes and Lasaga*
523. SEDIMENTARY GEOCHEMISTRY (2) Kinetics and thermodynamics of low-temperature processes in sediments. Applications to weathering processes, natural waters, deposition of sediments, and diagenesis. Prerequisite: Geosc. 430. *Lasaga, Schmalz, and Guber*
- \*524. (Mat.Sc.524) VIBRATIONAL SPECTRA OF MATERIALS AND MINERALS (2) Infrared and Raman spectroscopy of solid materials, with applications to mineralogy, materials characterization, and glass research. Prerequisites: Phys. 412, 471. *White*
- \*525. ELECTRON PROPERTIES OF MINERALS (2) Application of spectroscopy to mineralogy — crystal field, E.P.R., N.M.R., and Mossbauer spectral evidence of ordering, element distribution, and stabilities. Prerequisites: Phys. 412, 471. *White*
- \*527. MINERALOGY (3) Detailed study of the crystal structures and crystal chemistry of minerals. *Smith*
530. TOPICS IN HYDROTHERMAL GEOCHEMISTRY (2) Methods of obtaining data; their evaluation and use in the quantitative treatment of hydrothermal systems, primarily by thermodynamic methods. Prerequisites: G.M. 521, 522. *Lasaga and Barnes*
- \*532. (Mat.Sc. 532) CRYSTAL STRUCTURE ANALYSIS (2) Experimental techniques for, and the theory of crystal structure determination. Prerequisite: Geosc. (Mat.Sc.) 408.
- \*535. (Mat.Sc. 535) GEOMETRICAL CRYSTALLOGRAPHY (3) Derivation of lattices, types, point groups, and space groups, and group theory applied to crystallography and spectroscopy. *Ryba, Smith, and White*
540. ORE DEPOSITS I (3) Geochemistry and geology of ore deposits formed by igneous and high-temperature hydrothermal processes. Prerequisite: Geosc. 451. *Staff*
541. ORE DEPOSITS II (3) Geochemistry and geology of ore deposits formed by low-temperature hydrothermal, sedimentary, and metamorphic processes; continuation of G.M. 540. Prerequisite: G.M. 540. *Staff*
550. IGNEOUS AND METAMORPHIC PETROLOGY (4) Analysis of controls of mineralogy, elemental, and isotopic compositions of igneous rock series and of metamorphic rocks. Prerequisite: Geosc. 430. *Eggler and Kerrick*
551. PETROGENESIS (3) Application of theory and experimental results to the origin of igneous rocks and associated hydrothermal fluids. Prerequisites: G.M. 520, 521. *Burnham*
552. IGNEOUS PETROLOGY (3) Analysis of igneous rocks of the earth and other planetary bodies. Prerequisites: G.M. 519, 520, 550. *Eggler*
553. METAMORPHIC PETROLOGY (3) Seminar with directed reading on controls and processes in the evolution of metamorphic rocks. Prerequisites: G.M. 520, 521. *Kerrick*
560. KINETICS OF GEOLOGICAL PROCESSES (3) General development of the kinetic theory of crystal growth, diffusion, irreversible thermodynamics, and heterogeneous reactions needed for geosciences and related fields, with applications to current problems. Prerequisites: Chem. 451, G.M. 521. *Lasaga*
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

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\*Offered alternate years.



## GEOLOGY (GEOL)

ROBERT SCHOLTEN, *In Charge of Graduate Programs in Geology*  
303 Deike Building  
814-865-6393

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Roger J. Cuffey, Ph.D. (Indiana) *Professor of Paleontology*  
Alan Davis, Ph.D. (Durham) *Professor of Geology*  
David P. Gold, Ph.D. (McGill) *Professor of Geology*  
Albert L. Guber, Ph.D. (Illinois) *Associate Professor of Geology*  
Richard R. Parizek, Ph.D. (Illinois) *Professor of Geology*  
Robert F. Schmalz, Ph.D. (Harvard) *Professor of Geology*  
Robert Scholten, Ph.D. (Michigan) *Professor of Geology*  
William Spackman, Jr., Ph.D. (Harvard) *Professor of Paleobotany*  
Alfred Traverse, Ph.D. (Harvard) *Professor of Palynology*  
Barry Voight, Ph.D. (Columbia) *Professor of Geology*  
Eugene G. Williams, Ph.D. (Penn State) *Professor of Geology*  
Lauren A. Wright, Ph.D. (Cal. Tech.) *Professor of Geology*

### Associate Members of the Graduate Faculty

Thomas W. Gardner, Ph.D. (Cincinnati) *Assistant Professor of Geology*  
Rudy L. Slingerland, Ph.D. (Penn State) *Assistant Professor of Geology*

A general description of the Department of Geosciences is given on page 204. The Geology faculty offers programs in stratigraphy, paleontology, sedimentation, paleobotany, palynology, regional and structural geology, geomorphology, ground water geology, engineering geology, marine geology and chemical oceanography, coal geology, coal petrology, geology of metallic and nonmetallic deposits, and economic geology.

### Master's Degree Requirements

The master's degree requirements of the Geology program are those of the Graduate School. A candidate for the M.S. degree may, after consultation with his or her adviser, elect to defend either a thesis or a paper written in the format of the journal, agency report, bulletin, etc., to which it is to be submitted. There is no distinction between these options with regard to level or quality of the research required. The thesis or written report must be defended in an oral examination.

### Doctoral Degree Requirements

All graduate students in the Geology program who wish to be admitted to the Ph.D. candidacy must take a formal candidacy examination administered by a standing committee of three members representing the major disciplines (biogeology, structural and economic geology, and stratigraphy and surface process) plus the potential thesis adviser and another faculty member appointed by the program chairman. The potential candidate must (1) have an adviser willing to sponsor him or her for the examination; (2) have completed and passed the master's degree, or successfully petitioned to bypass the master's degree; (3) be in good standing with the admissions requirements; i.e., a student admitted for a terminal M.S. degree must reapply for admission in the fall semester competition.

The candidacy examination consists of an oral examination of about three hours duration, and upon the discretion of the committee, it may be followed by an additional oral or written examination. Incoming students with a master's degree must take this examination before the end of their second semester in residence. Students who either bypass or earn a master's degree at Penn State must take the candidacy examination within four months of defending their M.S. thesis or their bypass petition.

The comprehensive examination of the Geology program consists of an oral examination administered by the student's doctoral committee. Normally, this examination lasts about three hours and probes in depth the knowledge in the areas of the student's specialization. At the discretion of the committee it may be followed by a written examination.

The Ph.D. foreign language requirements may be met by the same criteria used by the Geochemistry and Mineralogy program.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid

described in the STUDENT AIDS section of the Graduate Bulletin, the following award typically has been available to graduate students in this program:

SOHIO. FIELD RESEARCH FUND — Stipend, \$7,000 per year.

## GEOLOGY (GEOL)

502. (G.M. 502) CARBONATES IN THE MARINE ENVIRONMENT (3) Ancient carbonate rocks and recent carbonate sediments, with emphasis on modern field and laboratory methods and a multidisciplinary approach. *Schmalz*

503. PALEONTOLOGY (3-6 per semester, maximum of 9) Morphology of animal groups significant for their fossils; nature of species and faunal zones. Seminars may be arranged for studies of special fossil groups, microfossils, paleoecology. *Cuffey*

504. HISTORY AND FOUNDATIONS OF GEOLOGY (2-4) Theoretical aspects of geology: spatiotemporal organization of matter, dynamic processes, sequential development; basic patterns and history of scientific thought. *Williams*

505. QUANTITATIVE PHYSICAL SEDIMENTOLOGY (3) Principles of fluid mechanics and mathematical modeling; their use in describing sediment transport, sedimentary structure, and sedimentary environments. Prerequisite: Geosc. 330. *Slingerland*

506. SEDIMENTS OF THE WORLD (2-3 per semester, maximum of 6) Evolution of sediments from Archean to recent; relationship of sedimentation to geotectonism; kratonic and geosynclinal sediments; cyclicity. Prerequisites: Min. 512, 514. *Scholten and Williams*

508. CLASTIC DEPOSITIONAL ENVIRONMENTS (3) Readings, group discussions, and field work on processes and sedimentary responses of common rock-forming environments. Prerequisite: Geosc. 439. *Slingerland*

509. (Mn.Ec. 509) GEOLOGY AND ECONOMICS OF THE CONSTRUCTION MATERIALS (3) Occurrence, origin, and marketing of the mineral materials used by the construction industry. Economic and geologic evaluation of actual deposits. *Schenck and Wright*

510. (Mn.Ec. 510) GEOLOGY AND ECONOMICS OF THE INDUSTRIAL MINERALS (3) Occurrence, origin, and marketing of the industrial minerals and evaluation of deposits. Chemical and ceramic raw materials emphasized. *Schenck and Wright*

524. COAL PETROLOGY (1-6) Microscopy, source materials, coalification, constitution, classification of peats, lignites, bituminous coal, anthracite. *Davis*

526. (Biol. 526) PROBLEMS IN PALYNOLOGY (1-6) Individual research projects in various aspects of palynology, especially palynostratigraphy and paleoecological palynology. Prerequisite: Biol. 423. *Traverse*

541. ENVIRONMENTAL GEOLOGY (1-3) A multidisciplinary study of the impact of man-induced stress on the environment. Prerequisite: Geosc. 452.

542. QUANTITATIVE METHODS IN HYDROGEOLOGY (1-4) Investigation of groundwater systems and resources, emphasizing both the practical use and limitations of modeling techniques. Prerequisite: Geosc. 452.

545. GLACIAL GEOLOGY (3) Glaciers: their characteristics, causes, deposits, landforms, effects in periglacial regions. *Parizek*

546. PRINCIPLES OF PHOTOGEOLOGY (3) Use of aerial photographs and mosaics in structural, geomorphic, and rock distribution studies and in compilation of maps. Prerequisites: Geosc. 462, 465. *Gold and Gardner*

551. DYNAMIC STRUCTURAL GEOLOGY AND GEOTECTONICS (3-6) Phenomena of fracturing, faulting, folding; stress and (finite) strain analysis, physical and analytical models; deformational environments; tectogenesis and orogenesis. *Scholten and Wright*

555. ADVANCED STRUCTURE AND PETROFABRICS (1-3) Macroscopic and mesoscopic recognition, measurement, and interpretation of small-scale rock structures and mineral orientation patterns in deformed rocks. *Gold*

562. FLUVIAL GEOMORPHOLOGY (3) Process-oriented analysis of the variables of the fluvial system, emphasizing man's interaction. *Gardner*



563. **HILLSLOPE EVOLUTION (3)** Analysis of hillslope processes and forms. Topics include evolutionary theories, climate and tectonic influence, stability-instability, and human impact. Prerequisite: introductory course in geomorphology. *Gardner*

571. **FIELD PROBLEMS IN APPALACHIAN GEOLOGY (2)** Geologic history of the central Appalachians as deduced from field studies. *Slingerland*

590. **COLLOQUIUM (1-9)**

596. **INDIVIDUAL STUDIES (1-9)**

597. **SPECIAL TOPICS (1-9)**

## GEOPHYSICS (GPHYS)

SHELTON S. ALEXANDER, *In Charge of Graduate Programs in Geophysics*  
403 Deike Building  
814-865-2622

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Shelton S. Alexander, Ph.D. (Cal. Tech.) *Professor of Geophysics*  
Earl K. Graham, Ph.D. (Penn State) *Professor of Geophysics*  
Roy J. Greenfield, Ph.D. (M.I.T.) *Professor of Geophysics*  
Benjamin F. Howell, Jr., Ph.D. (Cal. Tech.) *Professor Emeritus of Geophysics*  
Peter M. Lavin, Ph.D. (Penn State) *Associate Professor of Geophysics*

### Associate Members of the Graduate Faculty

Charles A. Langston, Ph.D. (Cal. Tech.) *Associate Professor of Geophysics*  
Randolph J. Martin III, Ph.D. (M.I.T.) *Associate Professor of Geophysics*

A general description of the Department of Geosciences is given on page 204. In the Geophysics program students may specialize in seismology, physical properties of rocks, exploration geophysics, geomagnetism, paleomagnetism, geoelectricity, gravity, wave propagation, time-series analysis, space applications of geophysics, tectonics, earth physics, and planetary sciences.

### Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.

For admission to the Geophysics program, the general admission standards of the geosciences department must be met. In addition, an applicant is expected to have had mathematics through differential equations; a standard introductory course each in physics, chemistry, and earth sciences; and at least 16 credits of intermediate-level work in any one or a combination of these subjects. Students may be accepted with a previous degree in geophysics, physics, mathematics, engineering, earth sciences, or a closely allied field.

### Master's Degree Requirements

Every graduate student is required to have passed the following courses or their equivalent either as a graduate student or as an undergraduate: Geosc. 465, Structural Geology; Geosc. 485, Applied Seismology; Geosc. 486, Potential Fields; and Geosc. 489, Dynamics of the Earth.

Every M.S. candidate must include in his or her major a minimum of four advanced (500-level) courses in geophysics exclusive of seminars, research, or independent study. At least 9 credits of course work must be taken in subjects other than geophysics, including at least one physics and one mathematics course at the intermediate or advanced level. Students must maintain a B average in all formal course work, excluding seminars and research. E.Mch. 524A and/or 524B may be taken in lieu of the foregoing physics and mathematics requirements. In addition, each M.S. student must take 1 credit of Seminar (Geophys. 590) each year and 6 credits of Independent Study (Geophys. 596 or

600) in his or her M.S. program. Students must also demonstrate ability in computer programming.

As part of the M.S. program each student is required to complete a thesis or written report. The latter is expected to conform to the same high scientific standards as a thesis. The thesis or written report must be defended in an oral examination.

## Doctoral Degree Requirements

Admission to Ph.D. candidacy is determined by a formal oral candidacy examination. In addition, before being admitted to Ph.D. candidacy in the Geophysics program, the student must be accepted by a member of the Geophysics faculty as a thesis advisee.

Each student seeking Ph.D. candidacy is required to take and pass at Penn State, either formally or by examination, the following six (18 credits total) candidacy courses: Geosc. 465, Structural Geology; Geosc. 485, Applied Seismology; Geosc. 486, Potential Fields; Geosc. 489, Dynamics of the Earth; one physics and one mathematics course at the intermediate or advanced level. (E.Mch. 524A and/or 524B are acceptable for this latter requirement.)

Courses which have the above courses specified as prerequisites or equivalent courses taken elsewhere (if approved) may be substituted for any of these course requirements. Ph.D. thesis research credits may not be scheduled until after a favorable candidacy evaluation. No research credits taken before this will be accepted as part of the work for the Ph.D., except for a maximum of 6 credits which leads to an acceptable master's thesis or report.

In addition to the foregoing candidacy course requirements, a Ph.D. student majoring in Geophysics must take in his or her graduate program at least 12 credits of 500-level course work in Geophysics aside from seminars, research, and independent study, and at least 21 credits in other subjects. Doctoral students in the Geophysics program also must take 1 credit of seminar (Geophys. 590) each year. If approved, equivalent courses taken elsewhere may be substituted for these requirements.

The candidacy and comprehensive examinations of the Geophysics program are oral examinations. No candidate may take either examination more than twice.

There is no foreign language requirement in the Geophysics Ph.D. program.

## Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

AMOCO FOUNDATION MASTERS FELLOWSHIP IN GEOPHYSICS — Available to an M.S. graduate student with interests in exploration geophysics; \$5,500 per academic year.

ARCO FELLOWSHIP IN GEOPHYSICS — \$8,000 per academic year.

CHEVRON FELLOWSHIP IN GEOPHYSICS — \$7,000 per year, plus tuition.

CO-OP PROGRAM WITH MARATHON OIL COMPANY — provides six months of training and experience in industry; stipend is variable according to student's background.

TENNECO FELLOWSHIP IN GEOPHYSICS — \$9,200 per academic year.

## GEOPHYSICS (GPHYS)

504. MULTIDIMENSIONAL SIGNAL PROCESSING (3) Methods of signal enhancement and detection for problems in one-, two-, or three-space dimensions and multichannel arrays of time series. Applications covered include potential fields, remote sensing imagery, and seismic arrays.

506. MATERIAL PROPERTIES AND THE CONSTITUTION OF EARTH (3) Application of the properties of materials to the composition and physical state of earth's crust, mantle, and core.

507. SEISMOLOGY (3 per unit)

*Unit A.* Basic theory; seismic methods for inferring structure of planetary interiors; observational techniques; seismic event location, magnitude, and damage potential.

*Unit B.* Advanced wave propagation theory; mathematical representation of seismic sources; inversion theory; computational methods.

508. TECTONICS (3) Seminar in the cause and nature of the principal deformations of the earth.

515. ADVANCED EXPLORATION GEOPHYSICS (2-6) Special topics and new developments in exploration geophysics; coverage (2 credits each) in gravity and magnetic, electrical, electromagnetic, or seismic methods.



517. **COMPUTATIONAL METHODS IN GEOPHYSICS (3)** Practical methods of modeling geophysical phenomena for geologic structures; data analysis techniques; systematic inversion of geophysical data; special mathematical approximations.

521. **THERMAL STATE OF THE EARTH (3)** Analytical and numerical solutions to earth-related heat conduction and convection problems; geothermal energy; earth's heat flow and temperature.

590. **COLLOQUIUM (1-3)**

596. **INDIVIDUAL STUDIES (1-9)**

597. **SPECIAL TOPICS (1-9)**

NOTE: See the *Geosciences (Geosc.)* listing for 400-level Geophysics courses. Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in geophysical studies are listed under Mineralogy.

## GERMAN (GER)

ERNST SCHÜRER, *Head of the Department*  
S-323 Burrowes Building  
814-865-5481

**Degrees Conferred:** Ph.D., M.A., M.Ed.

### Senior Members of the Graduate Faculty

Ernst A. Ebbinghaus, Ph.D. (Philipps University, Marburg) *Professor of German and Comparative Literature*

W. LaMarr Kopp, Ph.D. (Penn State) *Professor of German*

Rio Preisner, Ph.D. (Charles University, Prague) *Professor of German*

Ernst I. Schürer, Ph.D. (Yale) *Professor of German*

### Associate Members of the Graduate Faculty

Barton W. Browning, Ph.D. (California) *Associate Professor of German*

Manfred E. Keune, Ph.D. (Michigan State) *Associate Professor of German*

Willard Martin, Ph.D. (Penn State) *Assistant Professor of German*

Gerhard F. Strasser, Ph.D. (Brown) *Assistant Professor of German*

Vickie L. Ziegler, Ph.D. (Yale) *Associate Professor of German*

Programs of study with major emphasis upon literature, philology, culture, or the teaching of German lead to advanced degrees.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), including the Subject (Advanced) Test in German, or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Minimum qualifications for admission include 30 undergraduate credits in German beyond the intermediate level. Provision is made, however, for admission with limited deficiencies. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities; and interests.

### Master's Degree Requirements

Work for the master's degree can be completed in two semesters of full-time study or, if the student is a graduate assistant, in three to four semesters. The degree may be earned either by writing a thesis, recommended for students applying for doctoral candidacy, or by submitting an essay to the department and taking additional 500-level German courses in lieu of 6 credits of thesis research.

Course work in the M.A. program includes bibliography and research techniques, history of the German language, and seminars providing intensive study of selected authors or topics. Practical ex-

## GERMAN

perience in supervised teaching is required for all graduate degrees. For the final examination, the student chooses three areas of specialization.

In the M.Ed. program, the student may select courses in the history of the German language, linguistics, German culture and civilization, advanced German stylistics, and educational theory and policy in addition to courses in German literature. Courses taken in the Department of Education lead to certification for secondary schools in Pennsylvania.

### Doctoral Degree Requirements

For the Ph.D. degree there is no specific requirement. Upon passing a doctoral candidacy examination, the student selects those advanced courses and seminars which will help him or her prepare for the doctoral comprehensive examinations. The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of two foreign languages.

### Other Relevant Information

Penn State's Pattee Library maintains excellent holdings for research, including the Allison-Shelley Collection of Anglica, Americana, and Germanica; extensive collections of German Baroque literature on microfilm and of emblem books; and twentieth-century German literature, especially the works of German writers in exile since 1933. The Seminar Library in Burrowes Building serves the needs of students with reference works, German journals, newspapers, and an extensive textbook collection.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

**EXCHANGE FELLOWSHIP AT KIEL UNIVERSITY** — Available to graduate students in German and other fields for a full academic year. Students must have a good command of German. Stipend is approximately \$450 per month plus tuition.

**EDWIN ERLE SPARKS DISSERTATION FELLOWSHIP IN THE HUMANITIES** — Available to a doctoral candidate in one of the following graduate programs: classics, comparative literature, English, French, German, history, linguistics, philosophy, religious studies, Slavic languages and literatures, Spanish, and speech communication; stipend \$4,800 plus tuition. Apply to relevant department or program before February 1.

The above fellowships include grants-in-aid covering all tuition charges. Advanced graduate students who do not hold fellowships or assistantships also may apply for graduate grants-in-aid which cover tuition charges.

Graduate assistantships require teaching, under supervision.

## GERMAN (GER)

- 401. ADVANCED CONVERSATION AND COMPOSITION (4)
- 408. ADVANCED GERMAN BUSINESS COMMUNICATIONS (3)
- 411. THE TEACHING OF GERMAN (3)
- 412. STRUCTURAL ANALYSIS OF MODERN GERMAN (3)
- 430. HISTORY OF THE GERMAN LANGUAGE (3)
- 440. ADVANCED STUDIES IN GERMAN CULTURE AND CIVILIZATION (3)
- 443. (C.Lit. 443) LITERARY RELATIONS OF GERMANY WITH ENGLAND AND AMERICA (3-9)
- 445. THE VIKINGS (3)
- 452. LITERATURE OF THE RENAISSANCE (3)
- 460. LITERATURE OF THE BAROQUE (3)
- 461. LITERATURE OF THE ENLIGHTENMENT (3)
- 462. LITERATURE OF THE LATE EIGHTEENTH CENTURY (3)
- 470. GOETHE (3)
- 471. SCHILLER (3)
- 472. ROMANTICISM (3)
- 480. REALISM (3)
- 481. EARLY TWENTIETH CENTURY (3)
- 482. RECENT GERMAN LITERATURE (3)
- 495. INTERNSHIP (3-9)
- 496. INDEPENDENT STUDIES (1-18)



\*1G. ELEMENTARY GERMAN FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees.

\*2G. ELEMENTARY GERMAN FOR GRADUATE STUDENTS (3) Continuation of Ger.1G, with opportunity for reading in special fields.

500. BIBLIOGRAPHY AND RESEARCH TECHNIQUES (3) Introduction to tools and methods of research, designed for students preparing for independent investigation of problems in German literature and language.

501. SEMINAR IN GERMAN CONVERSATION AND COMPOSITION (3) Advanced study of German conversation and composition, with emphasis on syntax, style, and idiomatic constructions.

508. SEMINAR IN GERMAN BUSINESS COMMUNICATIONS (3) Practices and problems in the administration of German business organizations. Writing letters, reports, and other types of business communications.

520. INTRODUCTION TO MIDDLE HIGH GERMAN (3) Descriptive and historical grammar; readings in simple Middle High German texts.

521. READINGS IN MIDDLE HIGH GERMAN (3) Intensive reading in Middle High German literature, especially of the *Blütezeit*. Prerequisite: Ger. 520.

522. OLD HIGH GERMAN (3) Essentials of grammar, with special treatment of the High German sound shift and of ablaut and umlaut; reading of works written before 1100 A.D.

523. GOTHIC (3) Introduction to historical and comparative Germanic grammar; emphasis on the Gothic language and texts. Suitable for advanced students in English.

525. OLD ICELANDIC (3) Introduction to Old Icelandic grammar; readings in Old Icelandic prose. Suitable for advanced students in English.

531. SEMINAR IN MEDIEVAL GERMAN LANGUAGES AND LITERATURES (3-6)

540. SEMINAR IN GERMAN CULTURE AND CIVILIZATION (3) Examination of special problems in German culture and civilization.

541. SEMINAR IN THE LITERATURE OF THE REFORMATION AND BAROQUE (3-6)

551. SEMINAR IN THE LITERATURE OF THE ENLIGHTENMENT AND THE AGE OF GOETHE AND SCHILLER (3-6)

561. SEMINAR IN POST-IDEALISTIC LITERATURE (3-6)

571. SEMINAR IN MODERN GERMAN LITERATURE (3-6)

581. SEMINAR IN LITERARY GENRES (3-12) Special studies in the German lyric, drama, short story, and novel.

591. SEMINAR IN GERMAN LITERARY CRITICISM (3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

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\*No graduate credit is given for this course.

## HEALTH EDUCATION (HL ED)

RICHARD W. ST. PIERRE, *Chairman of the Department*  
19 White Building  
814-863-0435

**Degrees Conferred:** Ph.D., D.Ed., M.S., M.Ed.

### Senior Members of the Graduate Faculty

Edward E. Hunt, Ph.D. (Harvard) *Professor of Anthropology and Health Education*  
Jose de la Vega Mendez, Ph.D. (Minnesota) *Professor of Health and Applied Physiology*  
Robert E. Shute, D.Ed. (Penn State) *Associate Professor of Health Education*  
Richard W. St. Pierre, Ed.D. (North Carolina) *Associate Professor of Health Education*  
Edward W. Wickersham, Ph.D. (Wisconsin) *Associate Professor of Biology*

### Associate Members of the Graduate Faculty

Wesley F. Alles, Ph.D. (Illinois) *Associate Professor of Health Education*  
William L. Eck, Ed.D. (New York) *Associate Professor of Health Education*  
James M. Eddy, D.Ed. (Penn State) *Assistant Professor of Health Education*  
John W. Powell, Ph.D. (Penn State) *Assistant Professor of Health Education*

Health education is a profession which complements several health-related fields such as medicine, health administration, and public health. Students may emphasize either a school or community health education focus, and choose from a wide variety of interdisciplinary course offerings in health and related fields. The M.S. and Ph.D. degrees are academic degrees with a strong emphasis on research and the scientific and theoretical principles underlying effective health education. The M.Ed. and D.Ed. degrees are professional degrees emphasizing applied research on the problems of supervision, administration, and teaching. A nonthesis option is available for the M.Ed. degree. All programs of study require research experience to enable the student to analyze problems, assess information, draw logical conclusions, and apply research findings.

The faculty has diverse research interests related to such areas as sexuality, smoking, alcohol, teaching methodology, stress, death and dying, health behavior, health promotion, etc.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

A junior-senior grade point average of 3.00 is required for admission into the master's program. A doctoral applicant is expected to have at least a 3.30 academic average for completed master's work and at least one year of full-time professional experience in health education or a related field. All applicants are further evaluated on the basis of related course work, academic achievements, work experience, technical writing ability, letters of recommendation, and the Graduate Record Examination. All students must demonstrate proficiency in the use of the English language. Exceptions to admissions requirements may be made for students with special backgrounds, abilities, and interests.

### Master's Degree Requirements

A minimum of 30 graduate credits are required for the completion of the master's degree, although many students choose to take additional course work. A 6-credit thesis is required for the M.S. option, and a 3-credit master's paper is required for the M.Ed. degree. The M.S. thesis is expected to be research-based with a strong theoretical orientation. The M.Ed. paper is usually of an applied nature and directed toward contributing to knowledge in the areas of teaching, or educational administration and supervision. Projects such as a publishable article, an annotated bibliography, a curriculum package, a student survey, etc., are acceptable formats for the M.Ed. paper.

Candidates for the M.S. and M.Ed. degrees are required to take an intermediate-level statistics course and a research methods course, and must have at least 12 credits of 500-level courses (M.Ed. — 15 credits of 500-level courses). All students must take, or must have taken, an advanced course in health education methods and must take at least 9 additional credits in health education. At least 6



credits must be taken in supporting areas (psychology, health planning, nutrition, etc.) outside of the department.

### **Doctoral Degree Requirements**

*Admission to candidacy.* Once admitted to the doctoral program, all students must take a written and oral candidacy examination, which is usually given before the end of the first semester that the student is on campus. The examination covers four major areas of master's level preparation for health education: (1) scientific and theoretical foundations; (2) psychological and sociological foundations; (3) methodological and curricular approaches; and (4) research and evaluation techniques. The committee which evaluates the candidacy exam may (1) admit the student to candidacy, (2) require specific course work or other additional study to aid the student with deficiencies, (3) require the student to retake the examination at a later date, or (4) deny admission to candidacy for a doctoral degree.

*Required course work.* At least 50 percent of all course work must be at the 500 level. Both D.Ed. and Ph.D. students must take at least one advanced statistics course and must be able to demonstrate competency in the use of the computer and statistical program packages. In addition, doctoral students must give evidence of basic prerequisite course work, experience, or independent study in the following areas: sexuality, drug use/abuse, nutrition, man and disease, physiology/growth and development, advanced health education and methods, communications, behavior science/psychology, and research methods. Students must arrange, with their adviser, to correct any deficiencies.

*Ph.D. requirements.* Although not required by the department, Ph.D. students are encouraged to have a minor area of study. The communications and foreign language requirement for the Ph.D. may be satisfied by one of two methods: (1) by demonstrating intermediate knowledge of one foreign language and the selection of courses from appropriate communication areas; or (2) by selecting designated courses from areas including research design, statistics, and computer applications.

*D.Ed. requirements.* Students seeking the D.Ed. degree are required to have a minor in the field of education. The minor area adviser must be selected from the graduate faculty in the College of Education. A minimum of 15 credits of course work related to the field of education, and approved by the minor area adviser, will constitute a minor.

*Comprehensive examination.* Both Ph.D. and D.Ed. candidates are required to take a written and oral comprehensive examination once their course work is substantially completed. The examination is prepared by the student's doctoral committee and covers all phases of the student's doctoral work.

### **Other Relevant Information**

Students are assigned academic advisers upon admission to the department. However, students may change advisers once they have the opportunity to get to know the faculty. Students are responsible for asking faculty members to serve on their master's or doctoral committee. All students in residence are expected to become involved with the research and teaching activities within the department. A variety of enriching activities are made available to motivated students who wish to improve their teaching and research skills, or who want to get experience in working with schools or health-related agencies.

### **Student Aids**

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

### **HEALTH EDUCATION (HL ED)**

- 403. EMERGENCY MEDICAL TECHNOLOGY (4)
- 404. EMERGENCY MEDICAL TECHNOLOGY INSTRUCTOR (2)
- 405. ADMINISTRATIVE ASPECTS OF ATHLETIC TRAINING (3)
- 408. INJURY CONTROL (3)
- 421. INTEGRATING HEALTH EDUCATION INTO THE SCHOOL PROGRAM, K-12 (3)
- 432. SAFETY EDUCATION (3)
- 433. PRINCIPLES AND METHODS OF TEACHING SAFETY EDUCATION (3)
- 435. INTRODUCTION TO THERAPEUTIC MODALITIES (3)
- 436. APPLICATION OF PHYSICAL THERAPY MODALITIES (1)
- 443. ALCOHOL EDUCATION (3)
- 446. HUMAN SEXUALITY AS A HEALTH CONCERN (3)
- 456. ADVANCED TECHNIQUES IN SCHOOL COMMUNITY HEALTH EDUCATION (3)
- 457. CONSUMER HEALTH EDUCATION (3)
- 495. HEALTH EDUCATION PRACTICUM (3-10)

## HIGHER EDUCATION

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

511. (Anthy. 511) HEALTH IMPLICATIONS IN THE GROWTH AND DEVELOPMENT OF SCHOOL CHILDREN (3) Child growth and development emphasis for teachers; medical inspection and examination; preschool program; early habit formations.

513. (Anthy. 513) HEALTH IMPLICATIONS IN MATURITY AND AGING (3) Changes in the human body in maturity and aging; mechanisms of physiologic aging; implications for health and preventive medicine. Prerequisite: HI.Ed. (Anthy.) 511.

521. PROBLEMS IN SCHOOL HEALTH ADMINISTRATION (3) Critical concerns in the development and coordination of curriculum, policies, and evaluation of health education and services in school systems. Prerequisite: HI.Ed. 456.

530. (Ph.Ed. 530, Rc.Pk. 530) RESEARCH TECHNIQUES IN HEALTH AND PHYSICAL EDUCATION AND RECREATION (3) Research techniques, including methods, research design, techniques for data collection, as applied to relevant problems in the health education field.

552. CURRENT HEALTH EDUCATION ISSUES (3) Analysis of scientific and political foundations of current issues within health education tasks, with emphasis on research and action implications.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## HIGHER EDUCATION (HI ED)

ROBERT E. SWEITZER, *In Charge of Graduate Programs in Higher Education*  
328 Pond Laboratory  
814-863-2690

**Degrees Conferred:** Ph.D., D.Ed., M.Ed.

### Senior Members of the Graduate Faculty

Edward D. Eddy, Ph.D. (Cornell) *Professor of Higher Education*  
Hans Flexner, Ph.D. (Columbia) *Associate Professor of Higher Education*  
Gordon C. Godbey, Ed.D. (Harvard) *Professor of Education*  
Carl A. Lindsay, Ph.D. (Penn State) *Associate Professor of Education*  
Sebastian V. Martorana, Ph.D. (Chicago) *Professor of Education*  
Kathryn McDaniel Moore, Ph.D. (Wisconsin) *Associate Professor of Higher Education*  
Kenneth P. Mortimer, Ph.D. (California) *Professor of Higher Education*  
Robert E. Sweitzer, Ph.D. (Chicago) *Professor of Education*  
William Toombs, Ph.D. (Michigan) *Professor of Education*

### Associate Members of the Graduate Faculty

Richard P. Chait, Ph.D. (Wisconsin) *Affiliate Associate Professor of Education*  
Andrew T. Masland, Ed.D. (Harvard) *Assistant Professor of Education*

The graduate program in Higher Education has as its goal the preparation of individuals who will pursue careers and exert leadership in postsecondary education as administrators, faculty, or researchers in the nation's colleges and universities and in a variety of public and private agencies and associations in the United States and other nations. With emphasis on the systematic study of higher education, the program builds on the scholarly and scientific disciplines offered throughout the University and applies these studies to the professional functions and responsibilities which its graduates will assume, and to the knowledge of the field of higher education. The program is concerned with four broad areas of higher education study and with three areas of special emphasis: academic programs and evaluation, organization and administration, and perspectives of higher education policy and practice.

With mounting awareness of the changes occurring in various academic and professional fields, of the need for higher education reform, and of the need for improved articulation among the various



levels of education, the higher education faculty cooperates with other departments of the University to offer a number of courses and seminars for graduate students interested in pursuing a minor in higher education.

#### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

The best-qualified applicants will be accepted up to the number of spaces that are available for new students. The Miller Analogies Test (MAT) has been accepted by the program and authorized by the dean of the Graduate School for use in admission decisions as a substitute for the GRE. Applicants with a standardized test score above 60 on the MAT, or a total Verbal and Quantitative score above 1100 on the GRE, and with a junior-senior average of 3.00 and a graduate average of 3.50 are usually admitted to the Ph.D. and D.Ed. programs. Applicants with a junior-senior average of 2.70, a graduate average of 3.20, and an MAT score of 50 or a GRE total score of 1000 but with special backgrounds, abilities, and interests also may be admitted to the D.Ed. program with only the baccalaureate degree, but they will earn the master's degree en route.

#### **Master's Degree Requirements**

M.Ed. students are required to write a master's paper in lieu of a thesis in addition to the required 30 credits of course work. A minimum of 18 credits in course work must be taken at the 500 level, with at least 15 credits being in higher education courses.

#### **Doctoral Degree Requirements**

Ph.D. students should have a master's degree in one of the social sciences or a related discipline and experience in a college or university or education-related agency. Work needed to supplement this discipline background will have to be made up in residence at Penn State. At least 12 credits in research methods and/or statistics are required of Ph.D. students. D.Ed. students who do not have previous experience in higher education are expected to acquire the equivalent of one year of experience prior to receiving their D.Ed. degree. During the comprehensive examination, in addition to being examined in their area of specialization, all Ph.D. and D.Ed. students will be examined in five common higher education areas: history and philosophy, curriculum and instruction, organization and administration, higher education clientele, and research methodology.

#### **Student Aids**

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, a limited number of graduate assistantships, in addition to those available through the Higher Education program, are available to Higher Education majors with special competencies through the Center for the Study of Higher Education, 325 Pond Laboratory, University Park, PA 16802.

### **HIGHER EDUCATION (HI ED)**

545. HIGHER EDUCATION IN THE UNITED STATES (3) Introduction to the educational context and major organizational and academic characteristics of postsecondary education; analysis of issues and future trends.

546. COLLEGE TEACHING (2-3) Principles involved in teaching at the college level; effective use of teaching aids; criteria used in evaluation.

548. CURRICULUMS IN HIGHER EDUCATION (2-3) Various types of curriculums and philosophies underlying them; ways in which curriculums are developed; elective versus required courses; evaluation of achievement.

549. COMMUNITY JUNIOR COLLEGE AND THE TECHNICAL INSTITUTE (2-3) Distinctive contributions to meeting the need for postsecondary education; development, functions, curriculum and instruction, government administration, and finance.

## HISTORY

550. **EDUCATION FOR THE PROFESSIONS (3)** Professions: changing concepts and practices; social control and responsibilities; professional schools and university values; continuing professional education; academic professions; assessment.
552. **ADMINISTRATION IN HIGHER EDUCATION (3)** Philosophy of administration; principles of scientific management and their application in colleges and universities; case studies of administrative problems. Prerequisite: courses or experience in higher education.
554. **THE HISTORY OF AMERICAN HIGHER EDUCATION (3)** An examination of the development of American higher education against the background of influential social, political, economic, and intellectual issues.
556. **HIGHER EDUCATION STUDENTS AND CLIENTELE (3)** Characteristics of higher postsecondary education students and other clientele; changes during postsecondary education years and during college; educational challenges and responses.
558. **CURRICULUM DESIGN AND EVALUATION IN HIGHER EDUCATION (3)** Processes and methods of higher education curriculum design, implementation, and evaluation; appropriate resources and their practical application; illustrative case studies. Prerequisite: Hi.Ed. 548.
562. **ADMINISTRATION IN HIGHER EDUCATION II (3)** Application of social science theory and research to postsecondary education organizations and administration; use of research in administrative practice. Prerequisite: Hi.Ed. 552.
575. (Ed.Ad. 575) **ADMINISTRATION OF ADULT EDUCATION (3)** The organization of a program of adult education; its legal status, finances, selection of teachers, learning personnel, housing, and other administrative problems connected with adult education. Prerequisite: Ed.Ad. 480 or teaching or administrative or supervisory experience.
590. **COLLOQUIUM (1-3)**
595. **INTERNSHIP IN HIGHER EDUCATION (1-9)** Supervised experience in administrative offices, in research, on instructional teams, and in college teaching.
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**

## HISTORY (HIST)

GERALD G. EGGERT, *Head of the Department*  
601 Liberal Arts Tower  
814-865-1367

**Degrees Conferred:** Ph.D., D.Ed., M.A., M.Ed.

### Senior Members of the Graduate Faculty

Charles D. Ameringer, Ph.D. (Fletcher Sch. Law & Dipl.) *Professor of Latin American History*  
Eugene N. Borza, Ph.D. (Chicago) *Professor of Ancient History*  
Ira V. Brown, Ph.D. (Harvard) *Professor of American History*  
William J. Duiker III, Ph.D. (Georgetown) *Professor of East Asian History*  
Gerald G. Eggert, Ph.D. (Michigan) *Professor of American History*  
George M. Enteen, Ph.D. (George Washington) *Associate Professor of History*  
John B. Frantz, Ph.D. (Pennsylvania) *Associate Professor of History*  
Warren W. Hassler, Jr., Ph.D. (Johns Hopkins) *Professor of American History*  
Robert J. Maddox, Ph.D. (Rutgers) *Professor of American History*  
Robert K. Murray, Ph.D. (Ohio State) *Professor of American History*  
Dan P. Silverman, Ph.D. (Yale) *Associate Professor of History*  
E-tu Zen Sun, Ph.D. (Radcliffe) *Professor of Chinese History*  
S. V. Utechin, Dr. Phil. (Kiel, Germany) *Professor of Russian History*

### Associate Members of the Graduate Faculty

Richard L. Garner, Ph.D. (Michigan) *Associate Professor of History*  
Arthur E. Goldschmidt, Jr., Ph.D. (Harvard) *Associate Professor of History*  
Robert W. Green, Ph.D. (Iowa) *Professor of European History*  
Cyril E. Griffith, Ph.D. (Michigan State) *Associate Professor of History*  
Paul B. Harvey, Jr., Ph.D. (Pennsylvania) *Associate Professor of History*



Isabel F. Knight, Ph.D. (Yale) Associate Professor of History  
 Ronald W. Linker, Ph.D. (Johns Hopkins) Associate Professor of History  
 Jackson J. Spielvogel, Ph.D. (Ohio State) Assistant Professor of History  
 Phillip E. Stebbins, Ph.D. (Ohio State) Associate Professor of History  
 James Ross Sweeney, Ph.D. (Cornell) Associate Professor of History

The department offers graduate instruction, research opportunities, and practicums appropriate for a wide variety of careers: teaching history and/or social studies at all levels, positions with museums and archives, and careers in government, the foreign service, and applied history. Students desiring post-baccalaureate instruction prior to beginning professional school often find training in history useful. Both lecture-discussion courses and research seminars are offered in the following areas of history: Ancient, Medieval, Modern European, British, Russian and Soviet, American, African, Middle Eastern, East Asian, and Latin American.

### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

To be considered for admission, applicants must provide Graduate Record Examination scores and submit college transcripts which show (1) course work in European history from ancient through modern times and in American history from the Age of Columbus to the present, and (2) a minimum junior-senior grade-point average of 3.00 and better than 3.00 in all college-level history courses. Exceptions to the minimum grade-point averages may be made for students with special backgrounds, abilities, and interests. Applicants also must have three persons familiar with their competence in history send letters of recommendation on their behalf. Applicants should submit directly to the history department a specimen of their methodological competence (i.e., undergraduate history thesis, seminar paper, or equivalent research paper) as proof of ability in research skills.

Applicants who already hold a master's degree in history will be admitted to the doctoral program. All others will be admitted to the master's program.

### **Master's Degree Requirements**

Candidates for the M.A. or M.Ed. degree must earn a minimum of 30 credits of graduate-level work. Candidates select one of the areas of history listed above as their area of specialization and must pass a comprehensive examination in that area upon completion of their course work. A minimum of 6 credits each must be taken in an area of history other than the candidate's specialty and in a cognate field or archival option. For M.Ed. candidates, the cognate field must be in education. Master's candidates who write a thesis must take a minimum of 12 credits of course work at the 500 level and 6 credits of research at the 600 level. With the consent of their adviser, master's candidates may substitute 6 credits of 500-level course work in history and a paper for the 6 credits of 600-level work and thesis. M.A. candidates in all areas except U.S. and British history shall offer at the time of admission at least one academic year's work in foreign language appropriate to their area or demonstrate proficiency in such language by the beginning of their second year in the program.

### **Doctoral Degree Requirements**

Ordinarily, doctoral programs are limited to American, Ancient, Modern European, Russian and Soviet, East Asian, and Latin American history. Prospective doctoral candidates should inquire of the head of the department about the current availability of any of these or other areas before beginning work on a doctoral degree. Doctoral candidates must pass oral and written examinations in one of the above areas of history, in a field of specialization within that area, in a field in a second area of history, and in a cognate field consisting of 15 credits of work in a single discipline other than history or in two or more disciplines other than history where the course work is related to the subject of the candidate's research interest. Doctoral candidates must have, or acquire, a reading knowledge of two foreign languages or one foreign language and competence in quantitative techniques where appropriate to research to be done for the degree. A foreign language is not required for the D.Ed. degree, but the candidate must complete a minor in education. Three credits in historiography (Hist. 502 or its equivalent) are required of all doctoral candidates.

## Other Relevant Information

The department's graduate officer, who supervises the overall graduate program in History and maintains student records, will assign newly admitted graduate students to advisers on the basis of each student's expressed area of interest. Advisers provide career counseling, assistance in planning courses of study, guidance in choosing thesis and dissertation topics, and direction in conducting research. Students who serve as graduate assistants will be given a variety of experiences as they assist different professors, ranging from paper-grading and administering exams, to preparing and delivering occasional lectures, to conducting quiz sections for large lecture courses, to having, on occasion, complete responsibility for instruction in a section of a course.

## Student Aids

In addition to the fellowships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

**JAMES HAMILTON HARTZELL AND LUCRETIA IRVINE BOYD HARTZELL HISTORY AWARD** — A \$200-\$300 award made annually to a graduate student in history whose field of interest is Pennsylvania history.

**HILL FELLOWSHIPS FOR STUDY IN HISTORY** — Awarded periodically by the history department to doctoral candidates who are working on their dissertations. Amount of award varies.

**EDWIN ERLE SPARKS DISSERTATION FELLOWSHIP IN THE HUMANITIES** — Available to a doctoral candidate in one of the following graduate programs: classics, comparative literature, English, French, German, history, linguistics, philosophy, religious studies, Slavic languages and literatures, Spanish, and speech communication; stipend \$4,800 plus tuition. Apply to relevant department or program before February 1.

**EDWIN ERLE SPARKS FELLOWSHIPS IN THE HUMANITIES (8)** — Available to beginning graduate students in one of the following graduate programs: classics, comparative literature, English, French, German, history, linguistics, philosophy, religious studies, Slavic languages and literatures, Spanish, and speech communication; stipends \$3,800 plus tuition. Apply to relevant department or program before February 1.

## HISTORY (HIST)

402. THE RISE OF THE GREEK POLIS (3) *Borza*
403. ALEXANDER THE GREAT AND THE HELLENISTIC WORLD (3) *Borza*
405. THE PAX ROMANA (3) *Harvey*
407. EARLY MEDIEVAL SOCIETY (3) *Sweeney*
408. CHURCH AND STATE IN THE HIGH MIDDLE AGES (3) *Sweeney*
412. INTELLECTUAL HISTORY OF THE MIDDLE AGES (3) *Sweeney*
414. RENAISSANCE AND REFORMATION (3) *Spielvogel*
417. THE AGE OF ABSOLUTISM (3) *Green*
418. THE FRENCH REVOLUTION AND THE NAPOLEONIC ERA (3) *Green*
420. RECENT EUROPEAN HISTORY (3)
422. INTELLECTUAL AND CULTURAL HISTORY OF EUROPE SINCE 1800 (3) *Knight*
423. ECONOMIC HISTORY OF EUROPE SINCE 1750 (3) *Silverman*
427. GERMANY SINCE 1860 (3) *Silverman*
430. EASTERN EUROPE IN MODERN TIMES (3) *Enteen*
432. HISTORY OF RUSSIA TO 1700 (3) *Utechin*
433. IMPERIAL RUSSIA, 1700-1917 (3) *Utechin*
434. HISTORY OF THE SOVIET UNION (3) *Enteen*
436. GREAT BRITAIN UNDER THE TUDORS AND STUARTS, 1485-1688 (3) *Linker*
437. GREAT BRITAIN, 1688-Present (3)
440. COLONIAL AMERICA TO 1753 (3) *Frantz*
441. REVOLUTIONARY AMERICA, 1753-1783 (3) *Frantz*
442. THE EARLY AMERICAN REPUBLIC, 1783-1850 (3)
444. THE UNITED STATES IN CIVIL WAR AND RECONSTRUCTION (3) *Hassler*
445. THE EMERGENCE OF MODERN AMERICA (3) *Eggert*
446. AMERICA BETWEEN THE WARS (3) *Murray*
447. RECENT AMERICAN HISTORY (3) *Murray*
449. CONSTITUTIONAL HISTORY OF THE UNITED STATES TO 1877 (3) *Stebbins*



450. CONSTITUTIONAL HISTORY OF THE UNITED STATES SINCE 1877 (3) *Stebbins*
452. HISTORY OF U.S. FOREIGN RELATIONS (3)
454. AMERICAN MILITARY HISTORY (3) *Hassler*
458. (L.S. 458) HISTORY OF AMERICAN ORGANIZED LABOR SINCE 1877 (3) *Eggert*
459. SOCIAL AND CULTURAL HISTORY OF THE UNITED STATES SINCE 1783 (3) *Brown*
460. UNITED STATES FOREIGN INTELLIGENCE (3) *Ameringer*
467. LATIN AMERICA AND THE UNITED STATES (3) *Ameringer*
468. MEXICO AND THE CARIBBEAN NATIONS IN THE TWENTIETH CENTURY (3) *Ameringer*
471. HISTORY OF ARABIC CIVILIZATION, 600-1258 (3) *Goldschmidt*
472. THE OTTOMAN EMPIRE AND OTHER MUSLIM STATES (3) *Goldschmidt*
473. THE CONTEMPORARY MIDDLE EAST (3) *Goldschmidt*
478. HISTORY OF WEST AFRICA (3) *Griffith*
479. HISTORY OF IMPERIALISM AND NATIONALISM IN AFRICA (3)
483. CHINESE SOCIETY AND CULTURE TO 1800 (3) *Sun*
485. NINETEENTH-CENTURY CHINA (3) *Sun*
486. TWENTIETH-CENTURY CHINA (3) *Duiker*
488. TWENTIETH-CENTURY SOUTHEAST ASIA (3) *Duiker*
490. (L.St. 490) ARCHIVAL MANAGEMENT (1-3)
496. INDEPENDENT STUDIES (1-18)
497. SPECIAL TOPICS (1-9)
499. FOREIGN STUDY — HISTORY (1-6)
501. HISTORICAL METHODS (3) *Staff*
502. HISTORIOGRAPHY (3) *Borza and Enteen*
503. STUDIES IN GREEK HISTORY (3-6) *Borza*
504. STUDIES IN ROMAN HISTORY (3-6) *Harvey*
509. MEDIEVAL CIVILIZATION (3-9) *Sweeney*
515. THE AGE OF THE REFORMATION (3-6) *Spielvogel*
517. STUDIES IN EUROPEAN HISTORY TO 1900 (3-6) *Knight and Green*
520. STUDIES IN TWENTIETH-CENTURY EUROPE (3-6) *Silverman*
533. STUDIES IN RUSSIAN AND SOVIET HISTORY (3-6) *Enteen and Utechin*
537. STUDIES IN BRITISH HISTORY (3-6) *Linker*
540. STUDIES IN COLONIAL AND REVOLUTIONARY AMERICA (3-6) *Frantz*
543. THE UNITED STATES, 1783-1877 (3-6) *Brown and Hassler*
545. THE UNITED STATES, 1877 TO PRESENT (3-6) *Murray and Eggert*
550. STUDIES IN CONSTITUTIONAL HISTORY (3-9) A graduate seminar examining constitutional developments in their historical context through readings, class discussions, and research papers. *Stebbins*
553. DIPLOMATIC HISTORY OF THE UNITED STATES (3-6) *Maddox*
559. CULTURAL HISTORY OF THE UNITED STATES (3-6) *Brown*
569. SEMINAR IN LATIN-AMERICAN HISTORY (3-6) *Ameringer*
573. STUDIES IN MIDDLE EASTERN HISTORY (3-6) *Goldschmidt*
583. STUDIES IN ASIAN HISTORY (3-9) *Sun and Duiker*
591. ARCHIVES PRACTICUM (3-6) Training and supervised work experience in archival activities — Option A: Archival Management; Option B: Oral History. Prerequisite: Hist. (L.St.) 490.
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## HOME ECONOMICS EDUCATION (HE ED)

TWYLA M. SHEAR, *In Charge of Graduate Programs in Home Economics Education*  
212 Rackley Building  
814-865-5441

**Degrees Conferred:** Ph.D., D.Ed., M.S., M.Ed.

### Senior Members of the Graduate Faculty

Eloise Murray, Ph.D. (Penn State) *Associate Professor of Home Economics*  
Elizabeth M. Ray, Ph.D. (Cornell) *Professor of Home Economics Education*  
Twyla M. Shear, Ed.D. (Michigan State) *Professor of Home Economics Education*  
Susan F. Weis, Ph.D. (Penn State) *Associate Professor of Home Economics Education*

Research and graduate courses may be chosen to give emphasis to special areas of interest in Home Economics Education, such as curriculum development; evaluation; teaching at the elementary, secondary, adult, or higher education levels; supervision; administration in colleges; or research.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Students who have majored as undergraduates in some aspect of home economics and who have achieved a junior-senior grade-point average of at least 2.50 will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests. Students wishing to be admitted to the doctoral programs must have completed a master's degree and will be admitted subject to limitations of program resources. New admissions are accepted any semester.

### Degree Requirements

There is no foreign language requirement for degrees in the program.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## HOME ECONOMICS EDUCATION (HE ED)

- 406. AUDIO-VISUAL METHODS FOR HOME ECONOMICS (1-4)
  - 427. TEACHING HOME ECONOMICS (3)
  - 463. PRE-STUDENT-TEACHING SEMINAR (1)
  - 464. POST-STUDENT-TEACHING SEMINAR (1)
  - 477. CURRICULUM DEVELOPMENT FOR HOME ECONOMICS IN SECONDARY SCHOOLS (3)
  - 478. APPRAISING STUDENT PROGRESS IN HOME ECONOMICS (3)
  - 481. EMPLOYMENT PREPARATION PROGRAMS IN VOCATIONAL HOME ECONOMICS (3)
  - 482. POSTSECONDARY, ADULT, AND CONTINUING EDUCATION PROGRAMS IN HOME ECONOMICS (3)
  - 495. STUDENT TEACHING (6-9)
  - 496. INDEPENDENT STUDIES (1-18)
  - 497. SPECIAL TOPICS (1-9)
- 
- 502. HOME ECONOMICS INSTRUCTION AT THE COLLEGE LEVEL (3) Teaching techniques suitable for college instruction in home economics; for prospective home economics college teachers.
  - 503. HOME ECONOMICS TEACHER EDUCATION (3) Organization of college programs of teacher education; use of resources; records; field services; recruitment and selection of personnel. Prerequisite: two years' experience in teaching home economics.



504. **EDUCATIONAL ISSUES AND HOME ECONOMICS (3)** Contemporary issues in education and their relationship to the teaching of home economics. Prerequisite: teaching experience.
510. **EDUCATIONAL LEADERSHIP IN HOME ECONOMICS (2-6)** Principles of educational leadership for home economists preparing for administration; supervision of city and state programs; supervision of student teachers. Prerequisites: graduation from a four-year teacher education major and two years' teaching experience in home economics.
518. **EVALUATION OF HOME ECONOMICS PROGRAMS (3)** Methods of evaluating progress toward goals in home economics education and use of findings in program planning and revision.
521. **HOME ECONOMICS EDUCATION SEMINAR (2-3)** Selected topics and recent developments in home economics education. Conferences and guidance relative to individual research problems.
577. **CURRICULA IN HOME ECONOMICS (3)** Development of curricula in home economics. Prerequisite: H.E.Ed. 477.
595. **INTERNSHIP IN HOME ECONOMICS SUPERVISION AND ADMINISTRATION (2-8)** Opportunity to understudy an educational leader in student teacher supervision, department or college administration, or regional consultation. Prerequisite: H.E.Ed. 510.
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**
602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)**

## HORTICULTURE (HORT)

FRANCIS H. WITHAM, *Head of the Department*  
103 Tyson Building  
814-865-2571

**Degrees Conferred:** Ph.D., M.S., M.Agr.

### Senior Members of the Graduate Faculty

Ernest L. Bergman, Ph.D. (Michigan State) *Professor of Plant Nutrition*  
Richard Craig, Ph.D. (Penn State) *Professor of Plant Breeding*  
Paul Grun, Ph.D. (Cornell) *Professor of Cytology and Cytogenetics*  
Charles W. Heuser, Ph.D. (Rutgers) *Associate Professor of Horticultural Physiology*  
John W. Mastalerz, Ph.D. (Cornell) *Professor of Floriculture*  
C. Marshall Ritter, Ph.D. (Ohio State) *Professor of Pomology and Extension Specialist in Pomology*  
Jack C. Shannon, Ph.D. (Illinois) *Professor of Horticultural Physiology*  
Cyril B. Smith, Ph.D. (Penn State) *Professor of Plant Nutrition*  
Loren D. Tukey, Ph.D. (Ohio State) *Professor of Pomology*  
John W. White, Ph.D. (Penn State) *Professor of Floriculture*  
Francis H. Witham, Ph.D. (Indiana University) *Professor of Horticultural and Plant Physiology*

### Associate Members of the Graduate Faculty

Richard N. Arteca, Ph.D. (Washington State) *Assistant Professor of Horticultural Physiology*  
David J. Beattie, Ph.D. (Michigan State) *Assistant Professor of Ornamental Horticulture*  
Charles D. Boyer, Ph.D. (Penn State) *Associate Professor of Plant Breeding and Genetics*  
Richard H. Cole, Ph.D. (Penn State) *Associate Professor of Potato Management Extension*  
Roland R. Daniels, Ph.D. (Wisconsin) *Associate Professor of Horticulture*  
Kathleen B. Evensen, Ph.D. (Florida) *Assistant Professor of Postharvest Physiology*  
George M. Greene II, Ph.D. (Penn State) *Associate Professor of Pomology*  
Carl W. Haeseler, Ph.D. (Penn State) *Professor of Pomology*  
Chiko Haramaki, Ph.D. (Ohio State) *Professor of Ornamental Horticulture*  
E. Jay Holcomb, Ph.D. (Penn State) *Assistant Professor of Floriculture*  
Larry J. Kuhns, Ph.D. (Ohio State) *Assistant Professor of Ornamental Horticulture Extension*  
Michael D. Orzolek, Ph.D. (Maryland) *Associate Professor of Horticulture Extension*

Students may specialize in several phases of production, plant genetics and breeding, soils and plant nutrition, horticultural physiology, postharvest physiology, plant propagation, and agricultural meteorology. Students wishing additional credits in the commodity areas of floriculture, olericulture, ornamental horticulture, and pomology, or in the areas of specialization listed above, should register for Hort. 596.

## Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of the graduate program officer, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Prerequisites for admission vary according to the area of specialization, but basic courses in physical sciences, mathematics, biological sciences, communication skills, and social sciences and humanities are required. Students who lack prerequisite courses may be admitted but are required to make up deficiencies without degree credit.

Students with a 2.80 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students.

## Master's Degree Requirements

All M.Agr. candidates must present an acceptable paper on a selected professional problem, or a report of internship training. Up to 3 graduate credits will be given for an acceptable paper. The candidate may be required to provide one or more copies of the paper for the University. All M.S. degree candidates must take or must have taken at least one graduate course in biometry and must present two seminars (Hort. 590). The second seminar must be on the thesis research. A thesis is required for the M.S. degree.

## Doctoral Degree Requirements

The communication and foreign language requirement for the Ph.D. degree may be satisfied by one of four options: (1) comprehensive competence in one language; (2) reading examination or two-course sequence in two languages; (3) reading examination or two-course sequence in one language plus 6 credits in other communication skills; or (4) 6 credits in each of two areas of communication skills.

All Ph.D. candidates must present at least three seminars (Hort. 590) for credit. One seminar must be a report of the thesis research. Attendance at seminars is expected of all graduate students. All Ph.D. candidates must have completed before graduation Agro. 512 or its equivalent and two additional graduate courses in statistics.

An oral candidacy examination is administered after a student has completed 12 graduate credits beyond the baccalaureate and must be taken within two semesters after having earned 24 graduate credits.

Within one semester after passing the candidacy examination, the student's doctoral committee, with the thesis adviser in charge, will have the program planning meeting. The purposes of this meeting are to (1) determine the student's strengths and weaknesses in pertinent subject matter areas; (2) guide the student in developing a plan of study; and (3) review and discuss the proposed thesis research.

The comprehensive examination, composed of both written and oral parts, will be given when, in the student's and adviser's opinion, the student is ready for the examination, and when the communications requirements and essentially all courses have been completed.

After the thesis is completed and all other requirements for the Ph.D. have been met, the dean of the Graduate School will schedule the final examination. A major part of the examination will be an oral defense of the thesis.

## Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following award typically has been available to graduate students in this program:

**WALTER THOMAS MEMORIAL SCHOLARSHIP** — Available to students studying the nutrition of horticultural crops; stipend equivalent to a half-time assistantship. Apply through the Department of Horticulture.



**HORTICULTURE (HORT)**

- 401. PLANT PROPAGATION (3) *Haramaki or Beattie*
- 402. PLANT NUTRITION (2-3) *Bergman*
- 405. SENIOR SEMINAR IN HORTICULTURE (1-2)
- 407. PLANT BREEDING (3) *Boyer*
- 412. POST-HARVEST PHYSIOLOGY (3) *Evensen*
- 420. CHEMICAL GROWTH REGULATORS FOR HORTICULTURAL CROP PRODUCTION (3)
- 421. PLANT TISSUE CULTURE (3)
- 431. SMALL FRUIT CULTURE (3) *Daniels*
- 432. DECIDUOUS TREE FRUITS (3) *Tukey*
- 433. VEGETABLE CROPS (3) *Arteca*
- 434. NURSERY CROP PRODUCTION (3) *Beattie*
- 435. GREENHOUSE CROP PRODUCTION (3) *Holcomb*
- 444. ADVANCED PLANT BREEDING (4) *Craig*
- 453. FLOWER CROP PRODUCTION AND MANAGEMENT (3) *Holcomb*
- 455. RETAIL HORTICULTURE BUSINESS MANAGEMENT (3) *Wolnick*
- 495. INTERNSHIP (1-13)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 501. REPRODUCTIVE PHYSIOLOGY OF CULTIVATED PLANTS (3) Anatomical and physiological processes involved in sexual and asexual reproduction, including pollination, seed development, germination, rooting, grafting, and tissue culture.
- 503. AGRICULTURAL PRODUCTION SYSTEMS (3) Analyses of soil, plant, and atmospheric components in agricultural production. *Russo*
- 504. PHYSICS AND MANAGEMENT OF THE GREENHOUSE ENVIRONMENT (3) Evaluation of plant growth and development in an enclosed environment from both physiological and structural perspectives.
- 506. NUTRITION OF HORTICULTURAL CROPS (2-4) Principles, applications, and interpretations of diagnostic methods for determining fertilizer requirements of horticultural crops. *Smith*
- 507. PHYSIOLOGICAL GENETICS AND PLANT BREEDING (3) Inheritance and breeding of plants for biochemical and physiological characteristics. *Boyer*
- 512. ADVANCED TOPICS IN POSTHARVEST PHYSIOLOGY (3) Physiological processes associated with flower senescence, leaf senescence, and fruit ripening. Prerequisites: Hort. 412, Biol. 441. *Evensen*
- 520. ISOLATION AND CHARACTERIZATION OF PLANT GROWTH SUBSTANCES (2) Procedures for the isolation and characterization of known endogenous plant growth substances. Prerequisites: Hort. 420, Biol. 441. *Arteca*
- 524. EXPERIMENTAL PROCEDURES IN PLANT SCIENCE RESEARCH (3) Experimental methods, computer techniques, interpretation of statistical analyses, and communication of research results. Prerequisite: Agro. 512 or 3 credits in 400-level statistics. *Craig*
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## HUMAN DEVELOPMENT AND FAMILY STUDIES (HD FS)

ROBERT L. BURGESS, *In Charge of Graduate Programs in Human Development and Family Studies*  
S-137 Henderson Human Development Building  
814-863-0241

**Degrees Conferred:** Ph.D., M.S., M.Ed.

### Senior Members of the Graduate Faculty

Joseph H. Britton, Ph.D. (Chicago) *Professor of Human Development*  
Robert L. Burgess, Ph.D. (Washington, St. Louis) *Professor of Human Development*  
Steven J. Danish, Ph.D. (Michigan State) *Professor of Human Development*  
Anthony R. D'Augelli, Ph.D. (Connecticut) *Associate Professor of Human Development*  
Donald H. Ford, Ph.D. (Penn State) *Professor of Human Development*  
James Garbarino, Ph.D. (Cornell) *Associate Professor of Human Development*  
Bernard G. Guerney, Jr., Ph.D. (Penn State) *Professor of Human Development*  
Louise F. Guerney, Ph.D. (Penn State) *Associate Professor of Human Development*  
Laurie M. Gunter, Ph.D. (Chicago) *Professor of Nursing and Human Development*  
David F. Hultsch, Ph.D. (Syracuse) *Professor of Human Development*  
Ted L. Huston, Ph.D. (S.U.N.Y.) *Associate Professor of Human Development*  
Richard M. Lerner, Ph.D. (C.U.N.Y.) *Professor of Child and Adolescent Development*  
Gerald E. McClearn, Ph.D. (Wisconsin) *Professor of Human Development and Psychology*  
John R. Nesselroade, Ph.D. (Illinois) *Professor of Human Development*  
Donald L. Peters, Ph.D. (Stanford) *Professor of Human Development*  
Anne C. Petersen, Ph.D. (Chicago) *Professor of Human Development*  
Constantina Safilios-Rothschild, Ph.D. (Ohio State) *Professor of Human Development*  
K. Warner Schaie, Ph.D. (Washington) *Professor of Human Development and Psychology*  
Michael A. Smyer, Ph.D. (Duke) *Associate Professor of Human Development*  
Hugh B. Urban, Ph.D. (Penn State) *Professor of Human Development and Psychology*  
Fred W. Vondracek, Ph.D. (Penn State) *Associate Professor of Human Development*  
Sherry L. Willis, Ph.D. (Texas) *Associate Professor of Human Development*  
Joachim F. Wohlwill, Ph.D. (California) *Professor of Human Development*

### Associate Members of the Graduate Faculty

Jay Belsky, Ph.D. (Cornell) *Assistant Professor of Human Development*  
Ann C. Crouter, Ph.D. (Cornell) *Assistant Professor of Human Development*  
Terry Foch, Ph.D. (Colorado) *Assistant Professor of Human Development*  
Laurie Garduque, Ph.D. (U.C.L.A.) *Assistant Professor of Human Development*  
Louise Gentry, Ph.D. (Ohio State) *Professor of Home Economics Education and Human Development*  
Suzanne K. Getz, Ph.D. (Minnesota) *Associate Professor of Human Development*  
Stella Goldberg, Ph.D. (Columbia) *Professor of Child Development and Family Relations*  
Gunhild Hagestad, Ph.D. (Minnesota) *Assistant Professor of Human Development*  
Christopher Hertzog, Ph.D. (Southern California) *Assistant Professor of Human Development*  
Daniel J. Lago, Ph.D. (Penn State) *Assistant Professor of Human Development*  
Jacqueline V. Lerner, Ph.D. (Penn State) *Assistant Professor of Human Development*  
Ronald A. Madle, Ph.D. (Penn State) *Adjunct Assistant Professor of Human Development*  
Susan M. McHale, Ph.D. (North Carolina) *Assistant Professor of Human Development*  
Gordon K. Nelson, Ph.D. (Wisconsin) *Associate Professor of Human Development*  
Judith Newman, Ph.D. (Temple) *Assistant Professor of Human Development*  
Nancy J. Treat, Ph.D. (West Virginia) *Assistant Professor of Individual and Family Studies*

This interdisciplinary program is one of the graduate programs of the College of Human Development. It is administered through the Department of Individual and Family Studies. Human Development and Family Studies focuses on the developmental study of individuals, small groups, and families for the purposes of expanding basic knowledge and professional application. The perspective encompasses the individual life span, from infancy and childhood through later maturity and old age, as well as the full cycle of the family. For both individual and family, the perspective includes variations in functioning patterns and the use of resources; the impact of diverse social, economic, and cultural contexts upon behavior; conditions which promote adaptive individual, group, and family development; and the creation of techniques of accomplishing human development. Emphasis is upon the integration of knowledge from various fields for understanding and developing skills for careers in research and scholarship, teaching, program planning and evaluation, and other professional services. The faculty includes persons primarily in the behavioral and social sciences particularly committed to research and application in these multi- and interdisciplinary areas.

The student's program is expected to include work assuring both breadth in the major field and



depth within one of three program areas: family development, human development intervention, or individual development. Further specialization is possible in adult development and aging, child and adolescent development, cognitive development and functioning, early childhood services, family economics and management, family relationships, integrative theories of human development, interpersonal relationships, methods for studying change, and social-emotional development and change.

The Child Development/Child Services Laboratory is operated as part of the teaching and research program. Each of three units has observational facilities and rooms for study of individual and group behavior of children and adults. The Individual and Family Consultation Center provides facilities for the development and evaluation of educational programs for remediation of individual and family problems by professional and paraprofessional persons. The Institute for the Study of Human Development and the Gerontology Center provide opportunities for participation in research and evaluation projects. Additional resources are available in other parts of the University.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Entering students should have at least 6 credits in the biological and physical sciences; 12 in the social sciences and, depending upon proposed area of emphasis, basic courses in sociology, psychology, and economics; and 6 in developmental and family studies. Students not meeting these requirements may be admitted with limited deficiencies to be made up concurrently with their graduate work.

Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission, which, with rare exception, will be for fall semester only. Early application is required, and a special application to HDFS must be completed; additional information may be obtained from the professor in charge. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

### Degree Requirements

A research and evaluation methodology core, required of all students, may be satisfied by selections from a variety of courses across the campus. Use may be made also of courses in other parts of the college and University to build substantive competence in the program. The communication and foreign language requirement for the Ph.D. degree may be satisfied by options selected from designated areas including, but not restricted to, foreign languages. A minor or general studies group outside the major is required of all doctoral students.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## INDIVIDUAL AND FAMILY STUDIES (I F S)

- 410. COMMUNITIES AND FAMILIES (3)
- 411. THE HELPING RELATIONSHIP (3)
- 412. ADULT-CHILD RELATIONSHIPS (3)
- 413. DYSFUNCTIONS IN THE DEVELOPMENTAL PROCESS (3)
- 414. RESOLVING INDIVIDUAL AND FAMILY PROBLEMS (3)
- 415. PROGRAM DEVELOPMENT IN FAMILY RELATIONSHIPS (3)
- 416. CONSUMER ROLE OF FAMILY (3)
- 418. FAMILY RELATIONSHIPS (3)
- 419. PROBLEMS OF FAMILY FINANCIAL MANAGEMENT (3)
- 420. LABORATORY IN INDIVIDUAL AND FAMILY ENHANCEMENT (3)
- 424. ECONOMIC CONDITIONS IN RELATION TO THE FAMILY (3)
- 427. CONCEPTIONS IN DEVELOPMENT (3)
- 428. INFANT DEVELOPMENT (3)
- 429. ADVANCED CHILD DEVELOPMENT (3)

## HUMAN DEVELOPMENT AND FAMILY STUDIES

- 430. PRACTICUM IN PRESCHOOL GROUPS (1-10)
- 432. DEVELOPMENTAL PROBLEMS OF NORMAL CHILDREN (3)
- 435. DEVELOPMENTAL TRANSITION TO ADULTHOOD (3)
- 442. HOME MANAGEMENT EXPERIENCE (3)
- 445. (Psy. 445) DEVELOPMENT THROUGHOUT ADULTHOOD (3)
- 450. DEVELOPMENTAL CHILD PROGRAMS AND SERVICES (3)
- 453. FAMILY PARTICIPATION AND INVOLVEMENT IN CHILD SERVICES (3)
- 454. (C.&S. 454) DEVELOPMENT AND ADMINISTRATION OF CHILD SERVICE PROGRAMS (3)
- 470. (Psy. 470) SOCIAL LEARNING FOUNDATIONS OF BEHAVIOR CHANGE (3)
- 477. ANALYSIS OF FAMILY PROBLEMS (2-9)
- 490. INTRODUCTION TO FIELD EXPERIENCE (1)
- 491. DESIGN OF FIELD RESEARCH PROJECTS (2)
- 495. ADVANCED FIELD EXPERIENCE (1-12)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 500. NONTHESIS RESEARCH (1-9)
  
- 501. SEMINAR: ISSUES IN THE STUDY OF INDIVIDUAL AND FAMILY DEVELOPMENT (1-3) Reading, reports, and discussion of conceptual frameworks for multidisciplinary and developmental study of individuals and families.
  
- 504. PRACTICUM IN PROGRAM DEVELOPMENT FOR PRESCHOOL CHILDREN (2-6) Investigation, analysis, and report on the design, development, and evaluation of a selected program for preschool children. Prerequisites: 6 credits of individual development and I.F.S. 430.
  
- 506. PROJECTS IN DESIGN AND EVALUATION OF PROGRAMS FOR PRESCHOOL CHILDREN (2-4) Individual projects in the design, implementation, and evaluation of different teaching approaches with varying groups of children. Prerequisites: I.F.S. 504 and 3 credits in research methods.
  
- 508. PARENTAL EDUCATION (1-6) Implementing educational and preventive programs for parents; discussion and evaluation of theory and techniques.
  
- 511. MODIFYING CONJUGAL LIFE (1-9) Conceptual foundations, research procedures, and practicum experience in teaching effective communication and problem-solving skills in the marriage relationship. Prerequisites: 6 credits in individual development or psychology and 3 credits in statistics.
  
- 512. FILIAL RELATIONSHIP MODIFICATION (1-9) Theory, research, and practicum in teaching parents to resolve developmental problems in their own children. Prerequisites: 6 credits in individual development or psychology and 3 credits in statistics.
  
- 513. GROUP PROCEDURES IN INDIVIDUAL DEVELOPMENT (1-6) Theory, research, and practicum experience in the use of group methods for promoting individual development in different age groups. Prerequisites: I.F.S. 411 and research methods or statistics.
  
- 515. TEACHING INDIVIDUAL DEVELOPMENT AND FAMILY STUDIES (1-6) Objectives, techniques, materials, and evaluation in teaching at the secondary and college level, and in adult and public education programs.
  
- 520. SEMINAR IN PRENATAL AND INFANT DEVELOPMENT (1-6) Prenatal and infant development, with emphasis on multiple determinants of early development and their relationship to later behavior. Prerequisites: 6 graduate credits in individual development, psychology, or biological science and 3 credits in statistics.
  
- 522. SEMINAR IN DYSFUNCTION PROCESSES IN INDIVIDUAL DEVELOPMENT (1-6) Multiple processes involved in dysfunctional development in the individual across the life-span. Prerequisite: I.F.S. 413.
  
- 524. THEORETIC ANALYSIS OF FAMILY ECONOMIC AND MANAGERIAL BEHAVIOR (3) Conceptual approaches and major contributions to the study of the organizational, managerial, and economic functions of the family. Prerequisite: I.F.S. 418 or 424 or 477.
  
- 525. THEORIES OF FAMILY RELATIONSHIPS (3) Assessment of the utility of major theories for empirical analysis of interpersonal interactions among family members. Prerequisite: I.F.S. 418.
  
- 529. (Psy. 529) SEMINAR IN CHILD DEVELOPMENT (1-6) Readings and reports on recent findings in child development. Prerequisites: 6 graduate credits in child development, child psychology, or educational psychology, plus 3 credits in statistics.



536. (Psy. 536) **RESEARCH METHODS IN DEVELOPMENTAL PROCESSES (3)** Methodological issues in research on varying stages of development across the individual life-span. Prerequisites: 6 credits in individual development or psychology and a course in statistics.
539. **SEMINAR IN ADOLESCENT DEVELOPMENT (1-6)** Cultural, psychological, and biological aspects of the developmental transition to adulthood. Prerequisites: 6 credits in individual development or psychology and 3 credits in sociology and statistics.
543. **MODIFICATION OF FAMILY MANAGERIAL PRACTICES (1-3)** Conceptual issues, research, and practicum experience in assisting families in the solution of financial and managerial problems.
544. **SEMINAR IN DYSFUNCTIONAL PATTERNS IN FAMILY ORGANIZATION (1-6)** Processes of familial dysfunction and disorganization and their explanation in economic, social-psychological, and managerial terms. Prerequisite: I.F.S. 418 or 424 or Soc. 430.
545. **FAMILIES AND SOCIOECONOMIC SYSTEMS (1-6)** Functional interrelationships between families and social and economic systems. Prerequisites: I.F.S. 418, 424.
546. **SEMINAR IN FAMILY RELATIONSHIPS (1-9)** Interpersonal interaction within family systems throughout the life cycle. Prerequisite: I.F.S. 418.
549. (Psy. 549) **DEVELOPMENTAL THEORY (3)** Conceptual frameworks and major contributions to the study of individual development across the life-span. Prerequisites: 6 credits at the 400 level in individual development or psychology.
550. **SEMINAR IN FAMILY ECONOMICS AND MANAGEMENT (1-6)** Recent developments in the study of family economic and managerial practices.
579. **SEMINAR IN ADULT DEVELOPMENT AND AGING (1-9)** A seminar dealing with specific topics concerning adult development and aging. Prerequisites: I.F.S. (Psy.) 445, statistics.
590. **COLLOQUIUM (1-3)**
595. **FIELD PROJECTS IN INDIVIDUAL AND FAMILY STUDIES (1-9)** Supervised research or internship in human services program. Prerequisite: instructor's approval of proposed project.
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**

## HUMANITIES (HUMAN)

JOHN S. PATTERSON, *Division Head, Humanities*  
 The Capitol Campus  
 Middletown, PA 17057  
 717-948-6189

**Degree Conferred:** M.A.

### Senior Members of the Graduate Faculty

Mihailo Dordevic, Docteur es Lettres (Paris) *Professor of Humanities and Literature*  
 Robert J. Graham, Ph.D. (Pennsylvania) *Associate Professor of Humanities and American Studies*  
 Theodora R. Graham, Ph.D. (Pennsylvania) *Associate Professor of Humanities and English*  
 Theodore L. Gross, Ph.D. (Columbia) *Professor of English*  
 Irwin Richman, Ph.D. (Pennsylvania) *Professor of American Studies and History*  
 Nancy M. Tischler, Ph.D. (Arkansas) *Professor of English and Humanities*  
 George D. Wolf, Ph.D. (Pennsylvania) *Professor of American Studies and History*  
 Melvin H. Wolf, Ph.D. (Michigan) *Professor of Humanities and English*

### Associate Members of the Graduate Faculty

Michael L. Barton, Ph.D. (Pennsylvania) *Associate Professor of Social Science and American Studies*  
 Simon J. Bronner, Ph.D. (Indiana) *Assistant Professor of Folklore and American Studies*  
 Eton F. Churchill, M.F.A. (Tulane) *Assistant Professor of Humanities and Multimedia Journalism*  
 William J. Mahar, Ph.D. (Syracuse) *Assistant Professor of Humanities and Music*  
 John S. Patterson, Ph.D. (Brown) *Associate Professor of American Studies and History*  
 Kevin W. Sweeney, Ph.D. (Wisconsin) *Assistant Professor of Humanities and Philosophy*  
 Troy M. Thomas, Ph.D. (California) *Assistant Professor of Humanities and Art*  
 Elizabeth Winston, Ph.D. (Wisconsin) *Assistant Professor of Humanities and English*

## HUMANITIES

The master's degree program in Humanities provides the basis for highly individualized study of arts and ideas. It emphasizes the development of skills for interdisciplinary study of art, music, literature, philosophy, and related fields. Unlike traditional single-discipline programs, it assists students in defining what aesthetic, historical, formal, and cultural parallels make the expression and experience of art integrated rather than disparate.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Entering students are expected to have studied in two of the major disciplines, usually having a major in one and some course work in another. Exceptions may be made for those with special backgrounds or abilities, who are committed to attaining competence in two areas. An admissions committee interviews all applicants, in person or by telephone. Students with a 2.50 junior-senior average and with applicable undergraduate backgrounds will be considered for admission.

### Degree Requirements

To qualify for the M.A. in Humanities, the student must demonstrate competence in applying the methods of humanistic inquiry to a relevant subject area. A supervisory committee, selected by the student, works closely with the student to determine individual needs and guides the selection of courses, independent studies, and final production. A series of six 500-level courses is designed to assist students in developing both disciplinary and interdisciplinary skills. Independent studies and appropriate 400-level courses offer additional flexibility.

The degree program requires completion of 30 credits, with 18 credits at the 500 level. However, the degree is not simply a recognition of credits compiled; it testifies that the student has cultivated the necessary skills of analysis and synthesis and has successfully completed a master's production.

A full-time student can expect to complete the program in three semesters, a part-time student in six semesters.

### Other Relevant Information

For students planning to teach in a junior or community college, a teaching internship is available. Others interested in careers in media, or in television production or writing may enroll in specialized courses and take an internship in media once degree requirements have been fulfilled. A museum seminar and internship enables a qualified student to explore a number of careers.

Faculty members are frequently available for consultation and discussion. They are aware of and sensitive to the special needs of part-time students.

This program is available only at The Capitol Campus.

## HUMANITIES (HUM)

500. RESEARCH METHODS (3) Study of the methods and materials of scholarship, compilation of bibliographies, writing of scholarly papers, and proper documentation.

502. PERENNIAL ISSUES IN THE HUMANITIES (3) Recurrent issues viewed in terms of their significance to the artist, the historian, and the philosopher.

503. INTERRELATIONS IN THE HUMANITIES (3) The study and practice of the methods of conducting interdisciplinary research and of investigating and supporting interart analogies. Prerequisite: Hum. 500.

520. STUDIES IN STYLE (3) Study of prominent stylistic patterns, evaluating the essence of a style, and the varied responses of the artist and philosopher within a pattern.

525. STUDIES IN AESTHETICS (3) The foundation of art criticism: issues concerning the nature of art, its value, aesthetic attitude, and the grounds for judgment.

580. MASTER'S PRODUCTION (1-6) An original scholarly master's paper or creative production initiated by the student, supervised by an appropriate professor, and judged by a committee.

590. COLLOQUIUM (1-3)



596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

Additional courses may be taken from the following list and at the 400- or 500-level in related fields with the concurrence of the student's adviser.

AM.STD. 452. THE AMERICAN RENAISSANCE (3)

AM.STD. 459. AMERICA'S COMING OF AGE 1914-1939 (3)

AM.STD. 460. AMERICAN ART AND ARCHITECTURE (3)

AM.STD. 463. AMERICAN MUSIC (3)

C.ART 415. STUDIO ART (3)

C.ART 420. CRITICAL APPROACHES TO ART (3)

C.ART 427. MASTERPIECES OF ART (3)

C.ART 440. TOPICS IN ART (3)

HUM. 405. THE STUDY OF INTELLECTUAL AND CULTURAL HISTORY (3)

HUM. 409. MYTH AND CHILDREN'S LITERATURE (3)

HUM. 410. RELIGION AND CULTURE (3)

HUM. 430. PHILOSOPHY AND LITERATURE (3)

HUM. 441. MYTH, SYMBOL, AND RITUAL (3)

HUM. 453. LITERATURE AND SOCIETY (3)

HUM. 460. THEMATIC STUDIES (3)

HUM. 461. SELECTED PERIODS IN THE HUMANITIES (3)

LIT. 427. MASTERS OF LITERATURE (3)

LIT. 440. FORM AND FUNCTION (3)

LIT. 450. CULTURAL PATTERNS IN LITERATURE (3)

LIT. 460. LITERARY PERIODS (3)

LIT. 461. STUDIES IN LITERARY STYLE (3)

C.MUSIC 427. MASTERS OF MUSIC (3)

C.MUSIC 440. FORMS IN MUSIC (3)

C.MUSIC 460. STUDIES IN MUSICAL STYLE (3)

M-M 452. FILM AND CULTURAL VALUES (3)

M-M 480. STUDIES IN MEDIA (3)

PHLOS. 415. AESTHETICS (3)

PHLOS. 431. PHILOSOPHICAL PERSPECTIVES (3)

PHLOS. 447. PHILOSOPHICAL PERIODS (3)

PHLOS. 490. PHILOSOPHICAL TOPICS (3)

THTRE. 406. STUDIES IN THEATRE (3)

EDUC. 550. INTERNSHIP IN JUNIOR COLLEGE (3)

## INDUSTRIAL ENGINEERING (I E)

ALLEN L. SOYSTER, *Head of the Department of Industrial and Management Systems Engineering*  
207 Hammond Building  
814-865-7601

**Degrees Conferred:** Ph.D., M.S., M.Eng.

### Senior Members of the Graduate Faculty

Alan B. Draper, Ph.D. (Illinois) *Professor of Industrial Engineering*  
Ernest E. Ensore, Jr., Ph.D. (Penn State), P.E. *Associate Professor of Industrial Engineering*  
Inyong Ham, Ph.D. (Wisconsin) *Professor of Industrial Engineering*  
James P. Ignizio, Ph.D. (Virginia Polytech.) *Professor of Industrial Engineering*  
Wilbur L. Meier, Jr., Ph.D. (Texas), P.E. *Professor of Industrial Engineering*  
Claude D. Pegden, Ph.D. (Purdue) *Associate Professor of Industrial Engineering*  
David L. Raphael, M.A. (Michigan) *Professor of Industrial Engineering*  
Matthew Rosenshine, Ph.D. (S.U.N.Y.) *Professor of Industrial Engineering*  
Allen L. Soyster, Ph.D. (Carnegie-Mellon) *Professor of Industrial Engineering*

### Associate Members of the Graduate Faculty

M. Jeya Chandra, Ph.D. (Syracuse) *Assistant Professor of Industrial Engineering*  
Paul H. Cohen, Ph.D. (Ohio State) *Assistant Professor of Industrial Engineering*  
Andris Freivalds, Ph.D. (Michigan) *Assistant Professor of Industrial Engineering*  
Mark A. Fugelso, Ph.D. (Wisconsin) *Assistant Professor of Industrial Engineering*  
Jerry L. Goodrich, Ph.D. (Lehigh) *Assistant Professor of Industrial Engineering*  
Kenneth Knott, M.S. (Penn State), P.E. *Assistant Professor of Industrial Engineering*  
Eugene Kozik, Ph.D. (Pittsburgh) *Associate Professor of Industrial Engineering*  
Deborah J. Medeiros, Ph.D. (Purdue) *Assistant Professor of Industrial Engineering*  
Richard E. Zindler, Ph.D. (Michigan State) *Professor of Engineering Research*

Graduate study and research are conducted in operations research-management science, production engineering, process design, systems engineering, human engineering, and robotics.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Graduates in engineering, physical sciences, and mathematics who present a 2.50 junior-senior average will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

### Degree Requirements

The communication and foreign language requirement for the Ph.D. degree may be satisfied by an intermediate knowledge of one foreign language (Russian, German, French, or Japanese).

### Other Relevant Information

Students in this program may elect the dual-title degree program option in Operations Research for the Ph.D. and M.S. degrees (see p. 285).

The M.Eng. degree is also offered at the King of Prussia Center for Graduate Studies.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

W. S. ELLIOTT FELLOWSHIP — Available to a graduate student who is a graduate of The Pennsylvania State University and is interested in engineering research; stipend variable. Apply to Office of the Dean, College of Engineering, 101 Hammond Building.



**TAU BETA PI FELLOWSHIP** — Open to any member of Tau Beta Pi, the engineering honor society, for a year of advanced study. Up to eighteen awards of \$3,500 each are available. Applications and information may be obtained from the Office of the Dean, College of Engineering, 101 Hammond Building. Application deadline is February 15.

## INDUSTRIAL ENGINEERING (I E)

- 400. ENGINEERING FOR PRODUCTION (3)
- 401. WORK MEASUREMENT APPLICATIONS (3)
- 403. ENGINEERING ECONOMY AND STATISTICS (3)
- 404. MANAGEMENT SCIENCE (3)
- 405. LINEAR PROGRAMMING (3)
- 406. DESIGN OF PRODUCTION AND DISTRIBUTION SYSTEMS (3)
- 407. QUANTITATIVE METHODS IN INDUSTRIAL ENGINEERING III (3)
- 408. HUMAN FACTORS ENGINEERING (3)
- 414. MATERIALS JOINING PROCESSES AND PRINCIPLES (3)
- 423. QUALITY CONTROL AND RELIABILITY (3)
- 425. INTRODUCTION TO OPERATIONS RESEARCH (3)
- 426. INDUSTRIAL AUTOMATION (3)
- 427. SOLIDIFICATION OF CASTINGS (3)
- 428. FOUNDRY ENGINEERING (3)
- 432. INTRODUCTION TO RELIABILITY ENGINEERING (1-3)
- 438. METAL CUTTING PRINCIPLES AND PRACTICE (3)
- 439. ENGINEERING SYSTEMS OPTIMIZATION (3)
- 450. MANUFACTURING SYSTEMS ENGINEERING (3)
- 451. NUMERICAL CONTROL (3)
- 452. MICROCOMPUTERS — PROGRAMMING AND INDUSTRIAL APPLICATIONS (3)
- 453. SIMULATION MODELING OF INDUSTRIAL SYSTEMS (3)
- 454. APPLIED DECISION ANALYSIS (3)
- 456. (M.E. 456) INDUSTRIAL ROBOT APPLICATIONS (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 501. MANUFACTURING METHODS (2-8) Special projects including investigation, experimentation, design, and research of one or more special types of manufacture. Prerequisite: I.E. 400.
- 506. WORK DESIGN AND MEASUREMENT (3-9) Methods of research in motion and time study; critical analysis of current literature. Prerequisite: I.E. 401.
- 507. OPERATIONS RESEARCH: SCHEDULING MODELS (3) Scheduling models with simultaneous job arrival and probabilistic job arrival, network scheduling, and scheduling simulation techniques. Prerequisite: I.E. 425.
- 508. OPERATIONS RESEARCH: INVENTORY MODELS (3) A study of inventory theory, deterministic models, probabilistic models, multiproduct models in both the single and multiperiod modes. Prerequisite: I.E. 425.
- 509. OPERATIONS RESEARCH: WAITING LINE MODELS (3) Waiting line models including models with infinite queues, finite queues, single and multiple servers under various priorities and disciplines. Prerequisite: I.E. 425.
- 510. MATHEMATICAL PROGRAMMING (3) Study of advanced topics in linear programming including duality, decomposition, sensitivity analysis, parametric programming, and selected topics in mathematical programming. Prerequisite: I.E. 405.
- 511. EXPERIMENTAL DESIGN IN ENGINEERING (3) Statistical design and analysis of experiments in engineering; experimental models and experimental designs using the analysis of variance. Prerequisite: I.E. 323.
- 512. GRAPH THEORY AND NETWORKS IN MANAGEMENT SCIENCE (3) Prerequisite: I.E. 425.
- 513. REAL-TIME MICROCOMPUTER APPLICATIONS (3) Study of real-time industrial engineering microcomputer applications, including the hardware and software techniques necessary to implement these systems. Prerequisite: I.E. 452.

514. DATA MANAGEMENT SYSTEMS DESIGN (3) Computer-based technology and design requirements for data acquisition and entry, data communications, transaction management, data-base management, and data utilization. Prerequisite: I.E. 513.
515. COMPLEX LINEAR FLOW MODELS (3) Application of complex linear flow models in engineering and management science, including static and dynamic system simulations. Prerequisite: I.E. 405.
516. APPLIED STOCHASTIC PROCESSES I (3) Prerequisite: Stat. (Math.) 416.
518. PLASTIC DEFORMATION PROCESSES (3) Study of the principles, theories, technology, design, and application of plastic deformation processes to shape metals. Prerequisites: I.E. 214, Metal. 259.
519. DYNAMIC PROGRAMMING (3) Study of the concepts underlying model-building and optimization of dynamic systems with application to engineering, economic, and environmental systems. Prerequisite: I.E. 516.
520. GOAL PROGRAMMING (3) Study of concepts and methods in analysis of systems involving multiple objectives with applications to engineering, economic, and environmental systems. Prerequisite: I.E. 405 or Q.B.A. 451.
521. ENGINEERING SYSTEMS OPTIMIZATION (3) Fundamental theory of optimization, including classical optimization, search methods, functional optimization; with engineering applications as industrial, mechanical, and chemical processes. Prerequisites: Math. 220, FORTRAN programming ability.
522. INDUSTRIAL SYSTEMS SIMULATION (3) Study of discrete-event, network, and continuous simulation of industrial and manufacturing systems using the SLAM/GASP-IV languages; statistical techniques in simulation methodology. Prerequisites: I.E. 322 and FORTRAN programming ability.
528. METAL CUTTING THEORY (3) Study of the theory of metal cutting, contemporary and future problems of metal removal processes; critical analysis of current literature. Prerequisite: I.E. 438.
532. RELIABILITY ENGINEERING (3) Mathematical definition of concepts in reliability engineering; methods of system reliability calculation; reliability modeling, estimation, and acceptance testing procedures. Prerequisite: I.E. 323 or 3 credits in probability and statistics with a prerequisite of calculus.
538. EXPERIMENTAL INVESTIGATIONS IN MATERIALS PROCESSING (3) Experimental investigation on selected subjects in processing involving instrumentation, methods, and analysis. Prerequisite: I.E. 528.
550. MANUFACTURING SYSTEMS (3) Fundamental theory for analyzing manufacturing systems including structural analysis, optimization and economics of manufacturing systems, automated and computer-aided manufacturing. Prerequisite: I.E. 450.
551. COMPUTER CONTROL OF MANUFACTURING SYSTEMS (3) Analysis of microprocessor-controlled servo loops, adaptive control, stochastic methods in control; analysis of NC machines, robots, and their controllers. Prerequisites: I.E. 330, 451.
553. (Bioe. 553) ENGINEERING OF HUMAN WORK (3) Physics and physiology of humans at work; models of muscle strength; dynamic movements; neural control; physical work capacity; rest allocation. Prerequisite: Biol. 41 or 472.
554. PRODUCTION, PLANNING, AND CONTROL (3) Analysis of research literature for topics, including scheduling, capacity planning, and lot sizing applied to manufacturing and production. Prerequisite: I.E. 507.
555. PERFORMANCE EVALUATION OF QUEUEING (3) Study of the methodologies available to obtain the equilibrium results of open and closed queueing networks with single and multiple classes of customers. Prerequisite: I.E. 509.
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)



## JOURNALISM (JOURN)

DANIEL W. PFAFF, *In Charge of the Graduate Program in Journalism*  
215 Carnegie Building  
814-865-6597

**Degree Conferred:** M.A.

### Senior Member of the Graduate Faculty

Donald L. Smith, M.S. (Illinois) *Associate Professor of Journalism*

### Associate Members of the Graduate Faculty

R. Thomas Berner, M.A. (Penn State) *Assistant Professor of Journalism*  
William L. Dulaney, Ph.D. (Northwestern) *Professor of Journalism*  
Robert H. Farson, M.A. (Colgate) *Professor of Journalism*  
Marlowe D. Froke, M.S. (Northwestern) *Associate Professor of Journalism*  
H. Eugene Goodwin, M.A. (Iowa) *Professor of Journalism*  
John S. Nichols, Ph.D. (Minnesota) *Assistant Professor of Journalism*  
Vincent P. Norris, Ph.D. (Illinois) *Associate Professor of Journalism*  
Daniel W. Pfaff, Ph.D. (Minnesota) *Associate Professor of Journalism*  
John N. Rippey, M.S. (Columbia) *Assistant Professor of Journalism*  
Herbert J. Rotfeld, Ph.D. (Illinois) *Assistant Professor of Advertising*

The one-year program is intended to serve two kinds of students: those who enter with several years of media work experience who are interested in improving their job marketability or in broadening the range of their professional abilities, and those with little or no media experience who are interested in preparing for a career in journalism.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Students with a 3.00 junior-senior average are eligible for admission. Those with lower averages who have significant professional experience or other unusual qualifications also will be considered. Two letters of recommendation are required. They should be from persons closely familiar with the applicant's professional background and competencies. Applicants must submit an autobiographical statement of about 1,000 words indicating the nature of the applicant's interest in journalism or mass communications, reasons for wanting to do graduate work, and aspirations for the future.

### Degree Requirements

All candidates will be required to earn credits in prescribed course work and electives. In individual cases, it may be possible for a candidate to take up to 9 credits of work outside the School of Journalism. In all cases, the program must be substantially completed in twelve months.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## JOURNALISM (JOURN)

- 401. MASS MEDIA IN HISTORY (3)
- 403. LAW OF MASS COMMUNICATIONS (3)
- 405. POLITICAL ECONOMY OF COMMUNICATIONS (3)
- 407. ADVERTISING IN CONTEMPORARY SOCIETY (3)
- 409. NEWS MEDIA ETHICS (3)
- 411. CULTURAL ASPECTS OF THE MASS MEDIA (3)
- 413. THE MASS MEDIA AND THE PUBLIC (3)
- 415. CURRENT ISSUES IN ADVERTISING (3)

416. (Engl. 416) SCIENCE WRITING (3-6)
417. ADVERTISING AND CONSUMERISM (3)
419. (Sp.Com. 419) INTERNATIONAL TELECOMMUNICATIONS (3)
421. PUBLIC AFFAIRS REPORTING (4)
423. REPORTING OF CONTEMPORARY ISSUES (3)
425. NEWS EDITING AND EVALUATION (4)
441. ADVERTISING COMMUNICATIONS PROBLEMS (4)
442. ADVERTISING MESSAGE STRATEGY (3)
443. ADVERTISING MEDIA PLANNING (4)
444. ADVERTISING RESEARCH (3)
445. ADVERTISING CAMPAIGNS (4)
451. PUBLIC RELATIONS (3)
452. PUBLIC RELATIONS MEDIA AND METHODS (3)
453. PUBLIC RELATIONS PROBLEMS (3)
461. PHOTOGRAPHY FOR THE MASS MEDIA (3)
473. INTERNATIONAL MASS COMMUNICATIONS (3)
475. MASS COMMUNICATIONS RESEARCH (3)
477. JOURNALISM IN THE SCHOOLS (3-6)
492. PUBLIC AFFAIRS BROADCASTING (4)
495. INTERNSHIP (1-3)
496. INDEPENDENT STUDIES (1-18)
497. SPECIAL TOPICS (1-9)
499. (Sp.Com. 499) FOREIGN STUDY — MASS COMMUNICATIONS (1-9)
  
504. SEMINAR IN THE HISTORY OF MASS COMMUNICATION (3)
505. INTERNATIONAL COMMUNICATION PROBLEMS (3) Legal and communications problems of the international flow of news and opinion; international press codes.
506. INTRODUCTION TO MASS COMMUNICATIONS RESEARCH (3) The scientific method; survey of basic concepts of theoretical and empirical research; variety of methodology; criteria for adequate research.
508. THE LITERATURE OF JOURNALISM (3)
511. MASS COMMUNICATIONS RESEARCH METHODS II (3) Problems of bibliographical research; evaluation of sources and materials in mass communications history, biography, structure, ethics, and other areas. Prerequisite: Journ. 506.
513. CONSTITUTIONAL PROBLEMS OF THE NEWS MEDIA (3) Problems involving conflict between guarantees of press freedom in the First and Fourteenth Amendments and rights and privileges of others.
521. NEWS MEDIA AND PUBLIC OPINION (3) Problems in the function, techniques, and responsibilities of press, radio, and television in forming and interpreting opinion.
524. GOVERNMENT AND MASS COMMUNICATIONS (3) Problems of freedom of information; governmental efforts to control mass communication agencies; government news coverage; public information agencies.
540. SEMINAR IN ADVERTISING PROBLEMS (3)
585. COMPARATIVE THEORIES OF PRESS SYSTEMS (3) Institutional structure and normative functions of press systems in modern societies, as shaped by prevailing world view and social organization.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)



## LABORATORY ANIMAL MEDICINE (L A M)

C. MAX LANG, *Chairman of the Department of Comparative Medicine*  
The Milton S. Hershey Medical Center  
Hershey, PA 17033  
717-534-8460

**Degree Conferred:** M.S.

### Senior Members of the Graduate Faculty

Howard C. Hughes, V.M.D. (Pennsylvania) *Associate Professor of Comparative Medicine*  
C. Max Lang, D.V.M. (Illinois) *Professor of Comparative Medicine*  
William J. White, V.M.D. (Pennsylvania) *Associate Professor of Comparative Medicine*

### Associate Members of the Graduate Faculty

James W. Griffith, D.V.M. (Missouri) *Assistant Professor of Comparative Medicine*  
Suraj B. Singh, Ph.D. (Punjab Agr. Univ.) *Assistant Professor of Comparative Medicine*

The department offers a postdoctoral program for veterinarians leading to the Master of Science degree with a major in Laboratory Animal Medicine. Laboratory animal medicine is a specialty of veterinary medicine that is concerned with the biology of laboratory animals and their comparative relationships to man. Postdoctoral training in this discipline provides a broad, basic foundation upon which the individual can build a career in teaching and research in laboratory animal medicine and/or in the professional direction of research animal facilities. The program has a strong research-oriented base with emphasis on comparative medicine and pathology.

This program is offered only at The Milton S. Hershey Medical Center.

### Admission Requirements

With the approval of the dean of the Graduate School, the faculty of the graduate program in Laboratory Animal Medicine does *not* require Graduate Record Examination scores or scores from any substitute examination for admission to the program. Students with a 3.00 junior-senior average, with a doctor of veterinary medicine degree, and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

### Degree Requirements

The program requires two years for completion. Basically, the first year consists of formal course work, while the second year is devoted mainly to research and the development of clinical skills and techniques. A student must have earned a minimum of 12 credits in a major subject, 6 credits in a minor subject, and 6 credits of thesis research in order to receive the graduate degree. Approved minors have been established in anatomy, behavioral science, biological chemistry, microbiology, pathology, pharmacology, and physiology.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following award typically has been available to graduate students in this program:

U.S. PUBLIC HEALTH SERVICE TRAINEESHIPS IN LABORATORY ANIMAL MEDICINE — Available to selected graduate students in laboratory animal medicine who are planning research-oriented careers; stipend varies. Apply to the graduate program in Laboratory Animal Medicine (Hershey).

## COMPARATIVE MEDICINE (C MED)

501. BIOLOGY AND CARE OF LABORATORY ANIMALS (2) Presentation of the anatomic and physiologic characteristics of the commonly used laboratory animal species and their relation to biomedical research.

503. LABORATORY ANIMAL GENETICS (2) Genetic principles applied to laboratory animals used for investigations of diseases that may be controlled or influenced by genetic factors.

## LINGUISTICS

505. LABORATORY ANIMAL ZOONoses (2) Experimentally induced, spontaneous, and infectious diseases transmissible between man and animals, with special emphasis on etiology, differential diagnosis, and control.
507. TECHNIQUES OF LABORATORY ANIMAL EXPERIMENTATION (2) Techniques of drug administration, infusion, and collection of body fluids and materials; gnotobiology; use of radioisotopes and bioinstrumentation.
510. ANIMAL PHYSIOLOGICAL SURGERY (3) Selected operative procedures, demonstrating principles of physiology with modern biomedical instrumentation, will be followed through the postoperative period.
515. EXPERIMENTAL SURGERY OF LABORATORY ANIMALS (3) Surgical techniques, including nephrectomy and Goldblatt clamp, bladder and gastric pouches, bile duct cannulation, intraventricular operation, cardiac and cerebrovascular catheterization.
530. DISEASES OF LABORATORY ANIMALS I (3) Physiological and pathological expressions of both infectious and metabolic-degenerative diseases of rodents, with emphasis on diagnostic and control methods.
531. DISEASES OF LABORATORY ANIMALS II (3) Physiological and pathological expressions of both infectious and metabolic-degenerative diseases of nonhuman primates and other species of animals.
535. COMPARATIVE PATHOLOGY (3) Comparative pathologic characteristics of infectious and metabolic diseases of animals and man.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

## LINGUISTICS (LING)

PHILIP H. BALDI, *In Charge of Graduate Programs in Linguistics*  
310 Burrowes Building  
814-865-6873

**Degree Conferred:** M.A.

### Senior Members of the Graduate Faculty

Philip H. Baldi, Ph.D. (Rochester) *Professor of Linguistics and Classics*  
Robert S. Brubaker, Ph.D. (Illinois) *Professor of Speech*  
John B. Dalbor, Ph.D. (Michigan) *Professor of Spanish*  
Ernst A. Ebbinghaus, Ph.D. (Marburg) *Professor of German and Comparative Literature*  
Harvey R. Gilbert, Ph.D. (Wisconsin) *Associate Professor of Speech*  
John Hinds, Ph.D. (S.U.N.Y. at Buffalo) *Associate Professor of Speech*  
James E. Martin, Ph.D. (Illinois) *Associate Professor of Psychology*  
Warren T. Morrill, Ph.D. (Chicago) *Professor of Anthropology*  
Keith E. Nelson, Ph.D. (Yale) *Professor of Psychology*  
David S. Palermo, Ph.D. (Iowa) *Professor of Psychology*  
William R. Schmalstieg, Ph.D. (Pennsylvania) *Professor of Slavic Languages and Linguistics*  
H. Tracy Sturcken, Ph.D. (North Carolina) *Professor of Spanish*

### Associate Members of the Graduate Faculty

Ronald E. Buckalew, Ph.D. (Illinois) *Associate Professor of English*  
Donka F. Farkas, Ph.D. (Chicago) *Assistant Professor of Linguistics and French*  
Glen H. Helman, Ph.D. (Pittsburgh) *Assistant Professor of Philosophy*  
Philip M. Prinz, D.Ed. (Boston) *Assistant Professor of Speech Communication*  
Ellen Woolford, Ph.D. (Duke) *Assistant Professor of Linguistics and Anthropology*  
Paul A. Zawadzki, Ph.D. (Iowa) *Assistant Professor of Speech*

The Linguistics program offers two options for graduate study, one in general linguistics and one in applied linguistics. The general M.A. degree program includes courses in historical linguistics, phonology and syntax, psycholinguistics, experimental phonetics, semantics, and sociolinguistics. In the applied option, the candidate pursues general courses in syntax, semantics, and phonology, then



chooses, with the help of the graduate adviser, a coherent set of electives in a specialized area which may be a language or a related field, such as teaching English as a second language, psycholinguistics, or communication disorders. The program requirements allow for considerable flexibility in the choice of electives for students pursuing either the general or applied option. An acceptable thesis or paper must be submitted and a written comprehensive examination passed.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

The minimum requirement for admission to an advanced program will normally be a B.A. degree in linguistics or an equivalent in any of the interdisciplinary subjects recognized as a specialized area. Students with deficiencies will be required to register for a course in grammatical analysis and a course in phonetics/phonology.

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

### Degree Requirements

The M.A. in Linguistics requires 36 credits in either a general or an applied option. The general M.A. student must take two exams in a core theoretical area (syntax, semantics, phonology) and one exam in a third area (sociolinguistics, historical, psycholinguistics, or the third core area). Students in the applied M.A. must take one exam in applied linguistics, one in a core area, and one in a third area to be determined by the student's program (e.g., English as a Second Language, Communication Disorders, etc.).

In addition to completing the three exams successfully, each student must complete an original research paper done under the direction of a program faculty member. These papers are typically revised and expanded versions of outstanding term papers written for regular courses and must conform to acceptable standards of linguistic scholarship. Papers are judged by two faculty members. A copy of the final version must be submitted to the department. The M.A. student is expected to demonstrate reading proficiency in one foreign language.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

EDWIN ERLE SPARKS FELLOWSHIPS IN THE HUMANITIES (8) — Available to beginning graduate students in one of the following graduate programs: classics, comparative literature, English, French, German, history, linguistics, philosophy, religious studies, Slavic languages and literatures, Spanish, and speech communication; stipend \$3,800 plus tuition. Apply to relevant department or program before February 1.

### LINGUISTICS (LING)

- 400. INTERMEDIATE GRAMMATICAL ANALYSIS (3)
- 401. INTRODUCTION TO LINGUISTIC THEORIES (3)
- 402. HISTORICAL LINGUISTICS (3)
- 403. PHONOLOGICAL ANALYSIS (3)
- 404. GENERATIVE PHONOLOGY (3)
- 413. (Sp.Com. 413) EXPERIMENTAL LINGUISTICS (3)
- 415. CONTRASTIVE ANALYSIS (3)
- 420. (Psy. 420) ADVANCED PSYCHOLINGUISTICS (3)
- 448. LANGUAGE VARIATION (3)
- 449. INTRODUCTION TO SEMANTICS (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

## MAN-ENVIRONMENT RELATIONS

500. **GENERATIVE LINGUISTICS (3)** Types of grammatical rules and their interrelations; algorithm for assigning structural descriptions; evaluation procedure for selecting best compatible grammar. Prerequisite: Ling. 400.
503. **GENERATIVE SYNTAX (3)** Grammatical rules specifying well-formed strings; conditions on analyzability and assigning of structural descriptions; deviation from well-formedness. Prerequisite: Ling. 500.
504. **GENERATIVE PHONOLOGY (3)** Distinctive feature theory in the generative framework; articulatory and acoustic correlates; nonphonemic features. Prerequisite: Ling. 500.
505. **SEMINAR IN HISTORICAL LINGUISTICS (3)** Detailed study of some problem of historical linguistics, e.g., the laryngeal theory, Indo-European ablaut, etc. Prerequisite: one course in historical linguistics.
517. (Cm.Dis. 517) **THEORETICAL BASES OF LANGUAGE DISORDERS IN CHILDREN AND ADULTS (3)** Application of linguistic theory to the understanding of communication disorders, with clinical implications for speech and language therapy. Prerequisites: 12 credits in communication disorders, or related fields, including a course in language acquisition.
520. (Psy. 520) **SEMINAR IN PSYCHOLINGUISTICS (3)** Consideration of theoretical and research issues relevant to psychological aspects of language sounds, syntax and semantics, and other cognitive support.
551. (Sp.Com. 551) **LINGUISTIC ANALYSIS OF A NON-INDO-EUROPEAN LANGUAGE (3)** An investigation into the phonological, morphological, syntactic, and discourse structures of a selected non-Indo-European language. Prerequisites: Ling. 400 or 403 or Sp.Com. 434.
590. **SEMINAR IN INTERDISCIPLINARY LINGUISTICS (3-12)** Methods of research. Common and individual investigations in interdisciplinary fields of linguistics in consultation with one or more interdisciplinary instructors. Prerequisite: Ling. 500.
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**
602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)**

## MAN-ENVIRONMENT RELATIONS (M E R)

RAYMOND G. STUDER, *Program Head*  
S-126 Henderson Human Development Building  
814-865-1467

**Degrees Conferred:** Ph.D., D.Ed., M.S., M.Ed.

### Senior Members of the Graduate Faculty

Peter B. Everett, Ph.D. (North Carolina) *Associate Professor of Man-Environment Relations*  
M. Powell Lawton, Ph.D. (Columbia) *Adjunct Professor of Human Development*  
Stuart H. Mann, Ph.D. (Case Western Reserve) *Professor of Operations Research*  
Arthur H. Patterson, Ph.D. (Northwestern) *Associate Professor of Environment and Behavior*  
Richard R. Ritti, Ph.D. (Cornell) *Professor of Organizational Behavior*  
Raymond G. Studer, Jr., Ph.D. (Pittsburgh) *Professor of Environmental Design*  
Theodore R. Vallance, Ph.D. (Syracuse) *Professor of Human Development*  
Joachim F. Wohlwill, Ph.D. (California) *Professor of Human Development*

### Associate Members of the Graduate Faculty

Sidney Cohn, Ph.D. (North Carolina) *Professor of Urban Design*  
Robert M. Griffin, Jr., Ph.D. (North Carolina) *Associate Professor of Environmental Planning*  
Philippus J. Loukissas, Ph.D. (Cornell) *Assistant Professor of Urban and Regional Planning*  
Willem vanVliet, Ph.D. (Toronto) *Assistant Professor of Man-Environment Relations*  
Gerald D. Weisman, Ph.D. (Michigan) *Assistant Professor of Man-Environment Relations*

The need for more effective communication and collaboration between social scientists and members of the design and planning professions has become increasingly evident in recent years. Through their efforts in devising transportation systems, shopping and recreational complexes, institutional facili-



ties, and housing projects for the poor and the elderly, architects, environmental designers, and city and regional planners are shaping our environment in ways that have definite and frequently profound effects on the persons using them. Yet these effects remain little understood, and potential problems arising because such designed environments do not always fit the behaviors of their users are of increasing concern.

The program in Man-Environment Relations educates students to deal with such issues by (1) developing an understanding of the interactions between environmental forces and human behavior, and by (2) learning to apply facts, principles, and theories from behavioral and social science to solve problems of the environmental designer, planner, and manager. Specifically, it aims to train students to undertake problem-focused research in both academic and applied settings and to translate the results of such research into terms useful to the creation of effective and satisfying environments for living and working.

For those students entering without a master's degree, an M.S. degree is awarded, but it is not considered a terminal degree or professional degree. Students enrolling in the program are expected to work for the Ph.D. degree. Students in the program may elect the dual-title degree program in Operations Research for the Ph.D. and M.S. degrees (see p. 285).

Graduate studies emphasizing Hotel, Restaurant, and Institutional Management (HR&IM) can be pursued through this program.

### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Students with a 3.00 junior-senior grade-point average will be considered for admission. Exceptions to this minimum average are sometimes made for students with special backgrounds, abilities, interests, and circumstances. Appropriate undergraduate preparation may be in the design and planning professions, environmental and urban studies, as well as other physical, social, or behavioral science programs relevant to the study of man-environment systems.

### **Master's Degree Requirements**

A master's thesis is required of all students. The thesis is to be based on original empirical research. A master's committee of three persons who oversee the master's thesis is appointed for each candidate. This committee gives the final master's exam, which is an oral defense of the master's thesis.

Each student must complete a core of three courses (M.E.R. 506, 507, and 508). These courses provide an overview of various environment-behavior research perspectives and their application to specified problems, as well as an introduction to research design and data collection methods, problem-solving methods for planning and policy development in environment-behavior systems, design of laboratory research and field-research methods, and the use of mathematical models.

### **Doctoral Degree Requirements**

Beyond the same core of three courses required for the master's degree, there are no other specific course requirements for the doctoral degree. However, prior to being allowed to schedule the Ph.D. comprehensive examination, a student must show satisfactory evidence of proficiency in statistics. This evidence can be provided by obtaining a grade of B or better in one of a number of 500-level statistics courses at the University.

The language or communication requirement for the Ph.D. can be fulfilled by (1) demonstrating proficiency in an approved foreign language, or (2) demonstrating proficiency in computer programming, or (3) completing a minor. The demonstration of proficiency is determined by an MER faculty committee.

### **Student Aids**

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

**MAN-ENVIRONMENT RELATIONS (M E R)**

- 413. APPLICATION OF BEHAVIOR-CHANGE STRATEGIES TO ENVIRONMENTAL PLANNING (3)
- 414. PLANNING COMMUNITY ENVIRONMENTS (3)
- 435. (Psy. 435) ENVIRONMENTAL STIMULATION AND BEHAVIOR (3)
- 442. ANALYTIC METHODS IN MAN-ENVIRONMENT RELATIONS (3)
- 447. (Soc. 447) ENVIRONMENT, ENERGY, AND SOCIETY (3)
- 452. MAN-ENVIRONMENT RELATIONS LABORATORY II (3 per semester, maximum of 6)
- 453. MAN-ENVIRONMENT RELATIONS LABORATORY III (3 per semester, maximum of 6)
- 465. BEHAVIORAL REQUIREMENTS FOR THE PLANNING AND MANAGEMENT OF HUMAN SERVICE FACILITIES (3)
- 471. HOUSING SPACE RELATED TO LIVING PATTERNS (3)
- 472. HOUSING PROBLEMS AND POLICIES (3)
- 480. METHODS FOR THE DESIGN OF ENVIRONMENT-BEHAVIOR SYSTEMS (3)
- 481. MANAGEMENT METHODS FOR ENVIRONMENT-BEHAVIOR SYSTEMS (3)
- 482. PLANNING METHODS FOR ENVIRONMENT-BEHAVIOR SYSTEMS (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 500. NONTHESIS RESEARCH (1-6)
- 501. PROBLEMS IN MAN-ENVIRONMENT RELATIONS (1-9) Individual directed study, investigation, and practice in selected aspects of man-environment relations.
- 502. SEMINAR IN MAN-ENVIRONMENT RELATIONS (1-9)
- 503. RESEARCH METHODS AND EVALUATION IN MAN-ENVIRONMENT RELATIONS (1-9)
- 505. ENVIRONMENTAL-BEHAVIORAL PROGRAMMING, DESIGN, AND MANAGEMENT (3) Applications of findings in the behavioral sciences to environmental design and management strategies; empirical, theoretical, and methodological issues.
- 506. THEORY AND APPLICATIONS IN ENVIRONMENT-BEHAVIOR RELATIONS (4) An overview of the field of man-environment relations with emphasis on current research perspectives and their application to real-world problems.
- 507. FIELD RESEARCH METHODS IN MAN-ENVIRONMENT RELATIONS (4) A survey of methods, problems of research design, and data collection in field research in man-environment relations.
- 508. PROBLEM-SOLVING METHODS IN MAN-ENVIRONMENT RELATIONS (4) Study of problem-solving methods for planning and policy development in environment-behavior systems, with laboratory and field applications.
- 510. PSYCHOLOGICAL FOUNDATIONS OF THE STUDY OF ENVIRONMENT-BEHAVIOR RELATIONS (3) Seminar relating the psychology of perception, cognition, motivation, personality, attitude formation, and psychological stress to aspects of the physical environment.
- 512. BEHAVIOR ANALYSIS OF ENVIRONMENTAL PROBLEMS (3) Analysis of behaviors contributing to environmental dysfunction. Behavior change strategies are proposed to deal with such problem areas as transportation, pollution, overpopulation.
- 515. ENVIRONMENTAL SYSTEMS THEORY (3) An in-depth review of those elements of general systems theory relevant to the analysis and organization of man-environment settings.
- 516. QUANTITATIVE METHODS IN ENVIRONMENTAL MANAGEMENT (3) The use of operations research and systems analysis in the modeling of man-environment systems. Prerequisite: M.E.R. 515.
- 520. RECENT DEVELOPMENTS IN TEXTILES (3) Developments in fibers, yarns, fabrics, finishes; effects on use and care; discussions and reports based on current literature.
- 534. (Stat. 534) DYNAMIC PROGRAMMING (3) The study of the concepts underlying model-building and optimization of dynamic systems; applications to engineering, economic, and environmental systems. Prerequisites: Stat. (Math.) 414; I.E. 405 or Q.B.A. 451.
- 597. SPECIAL TOPICS (1-9)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)



# MATHEMATICS (MATH)

ROGER P. WARE, *In Charge of Graduate Programs in Mathematics*  
229 McAllister Building  
814-865-7527

**Degrees Conferred:** Ph.D., D.Ed., M.A., M.Ed.

## Senior Members of the Graduate Faculty

George E. Andrews, Ph.D. (Pennsylvania) *Professor of Mathematics*  
Steve Armentrout, Ph.D. (Texas, Austin) *Professor of Mathematics*  
Paul Axt, Ph.D. (Wisconsin) *Professor of Mathematics*  
Christine W. Ayoub, Ph.D. (Yale) *Professor of Mathematics*  
Raymond G. Ayoub, Ph.D. (Illinois) *Professor of Mathematics*  
W. Dale Brownawell, Ph.D. (Cornell) *Professor of Mathematics*  
Frank R. Deutsch, Ph.D. (Brown) *Professor of Mathematics*  
Edward Formanek, Ph.D. (Rice) *Professor of Mathematics*  
Moses Glasner, Ph.D. (California, Los Angeles) *Associate Professor of Mathematics*  
Kyong T. Hahn, Ph.D. (Stanford) *Professor of Mathematics*  
Richard H. Herman, Ph.D. (Maryland) *Professor of Mathematics*  
Robert P. Hunter, Ph.D. (Louisiana State) *Professor of Mathematics*  
Donald G. James, Ph.D. (M.I.T.) *Professor of Mathematics*  
Thomas Jech, Ph.D. (Prague) *Professor of Mathematics*  
Ram P. Kanwal, Ph.D. (Indiana) *Professor of Mathematics*  
Allan M. Krall, Ph.D. (Virginia) *Professor of Mathematics*  
Stephen G. Krantz, Ph.D. (Princeton) *Associate Professor of Mathematics*  
Gerard Lallement, Doctorat es Mathematiques (Paris) *Professor of Mathematics*  
Peter Maserick, Ph.D. (Maryland) *Professor of Mathematics*  
Peter D. Morris, Ph.D. (Texas, Austin) *Associate Professor of Mathematics*  
John E. Olson, Ph.D. (Ohio State) *Associate Professor of Mathematics*  
Torrence D. Parsons, Ph.D. (Princeton) *Professor of Mathematics*  
Donald C. Rung, Ph.D. (Notre Dame) *Professor of Mathematics*  
Stephen G. Simpson, Ph.D. (M.I.T.) *Professor of Mathematics*  
Harlan R. Stevens, Ph.D. (Duke) *Associate Professor of Mathematics*  
Leonid N. Vaserstein, Ph.D. (Moscow State) *Professor of Mathematics*  
Roger P. Ware, Ph.D. (California, Santa Barbara) *Professor of Mathematics*  
William C. Waterhouse, Ph.D. (Harvard) *Professor of Mathematics*  
Boris Weisfeiler, Ph.D. (Steklov Mathematical Institute, Leningrad) *Associate Professor of Mathematics*  
Robert Wells, Ph.D. (Princeton) *Associate Professor of Mathematics*

## Associate Members of the Graduate Faculty

Joel H. Anderson, Ph.D. (Indiana) *Associate Professor of Mathematics*  
David M. Bressoud, Ph.D. (Temple) *Associate Professor of Mathematics*  
Joe P. Buhler, Ph.D. (Harvard) *Assistant Professor of Mathematics*  
Goong Chen, Ph.D. (Wisconsin) *Associate Professor of Mathematics*  
Paromita Chowla, Ph.D. (Colorado) *Associate Professor of Mathematics*  
William Hager, Ph.D. (M.I.T.) *Associate Professor of Mathematics*  
Robert E. Huff, Ph.D. (North Carolina) *Associate Professor of Mathematics*  
W.-C. Li, Ph.D. (California, Berkeley) *Associate Professor of Mathematics*  
Richard B. Mansfield, Ph.D. (Stanford) *Associate Professor of Mathematics*  
Mary McCammon, Ph.D. (London) *Associate Professor of Mathematics*  
William J. Mitchell, Ph.D. (California, Berkeley) *Associate Professor of Mathematics*  
David A. Sibley, Ph.D. (California Inst. of Tech.) *Associate Professor of Mathematics*  
Ross E. Staffeldt, Ph.D. (California, Berkeley) *Assistant Professor of Mathematics*

Graduate courses in all the principal branches of mathematics are offered regularly each year. The department is prepared to direct research in a variety of fields, including various branches of analysis, algebra, topology, number theory, applied analysis, and mathematical logic and foundations.

## Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are*

*in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

To be admitted to the Ph.D., D.Ed., or M.A. program without undergraduate deficiency, an applicant should have completed at least 18 credits in mathematics at the advanced undergraduate level (400 series or their equivalents). The undergraduate student is urged to take at least 6 credits in foundations of analysis (Math. 401-402), 6 in modern algebra (Math. 435-436), and 3 in topology (Math. 429) or their equivalents. These courses are essential preparation for the graduate program, and if they are taken after admission, a maximum of 6 credits may be counted toward an advanced degree.

Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

Entering graduate students in mathematics for whom English is not the first language are required to have a score of at least 550 on the TOEFL (Test of English as a Foreign Language) examination. Furthermore, the results of this examination must be received by the Department of Mathematics at least six months prior to the requested date of admission to the Graduate School.

## Master's Degree Requirements

For the M.A. degree the department offers two options: (1) the thesis option requires 12 credits of approved 500-series courses in mathematics, 6-9 credits of thesis, sufficient credits in approved 400- or 500-series courses to make a total of 30 credits, and a final oral examination based on the thesis and general course material; and (2) the nonthesis option requires 18 credits of 500-series courses in mathematics, sufficient credits in approved 400- or 500-series courses to make a total of 30 credits, and a term paper on an approved topic in mathematics. No final examination is given in this option. Under this option a student may also elect to take a minor in applied mathematics. In this case, he or she substitutes for 9 of the credits in mathematics 9 credits in the applied area — 6 of these credits must be at the 500 level. For both options, a grade of A or B is required in all courses.

The student also may elect to get concurrent M.A.'s in mathematics and another discipline. The program of study should satisfy the requirements for the master's degree in each department. However, 9 credits earned in cross-listed courses may count for a master's degree in both areas. The proposed program must be approved in advance by both the departments involved and by the Graduate School.

To be admitted to the M.Ed. program without undergraduate deficiency, an applicant should have completed at least 15 credits in mathematics at the intermediate level beyond calculus. The M.Ed. program does not require any 500-series courses, but the student is encouraged to select some at this level. Special courses have been instituted for the training of teachers. Among these are Math. 470, 471, and 472. These are acceptable to satisfy credit requirements only for the M.Ed. degree.

## Doctoral Degree Requirements

All Ph.D. students must take qualifying examinations in three fields of mathematics. Normally, these examinations are taken before the beginning of the third year of graduate study. Recommendations for advancement to Ph.D. candidacy are based on these examinations together with performance in the first two years of study. The comprehensive examination is given after approximately 60 credits are earned and after the student has passed reading examinations in two languages chosen from French, Russian, or German. The Ph.D. student also is expected to enroll in advanced seminars.

Outstanding students who do not continue in the doctoral program may petition the department for further support in order to pursue a second master's degree in another area to which mathematics is applicable.

For the D.Ed. degree, a student must pass qualifying examinations in algebra and analysis and a reading examination in French, German, or Russian before taking the comprehensive examination. In addition to the major thesis, the department requires participation in two semesters of research seminar. The D.Ed. program is intended for college teachers. Three years of experience in professional mathematics teaching on a full-time basis is required for admission. (Graduate teaching assistants are not included in this category.)

## Other Relevant Information

Students in this program may elect the dual-title degree program option in Operations Research for the Ph.D. and M.S. degrees (see p. 285).

A brochure describing more fully the graduate program in Mathematics is available from the Department of Mathematics.



### Student Aids

Graduate assistantships available through this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

### MATHEMATICS (MATH)

- 401. INTRODUCTION TO ANALYSIS I (3)
- 402. INTRODUCTION TO ANALYSIS II (3)
- 403. CLASSICAL ANALYSIS I (3)
- 404. CLASSICAL ANALYSIS II (3)
- 405. ADVANCED CALCULUS FOR ENGINEERS I: REAL VARIABLES (3)
- 406. ADVANCED CALCULUS FOR ENGINEERS II: COMPLEX ANALYSIS (3)
- 407. TENSOR ANALYSIS (3)
- 409. (Stat. 409) MATHEMATICAL STATISTICS I (3)
- 410. (Stat. 410) MATHEMATICAL STATISTICS II (3)
- 411. ORDINARY DIFFERENTIAL EQUATIONS (3)
- 412. FOURIER SERIES AND PARTIAL DIFFERENTIAL EQUATIONS (3)
- 413. OPERATIONAL MATHEMATICS (3)
- 414. (Stat. 414) INTRODUCTION TO PROBABILITY THEORY (3)
- 415. (Stat. 415) INTRODUCTION TO MATHEMATICAL STATISTICS (4)
- 416. (Stat. 416) STOCHASTIC MODELING (3)
- 417. QUALITATIVE THEORY OF DIFFERENTIAL EQUATIONS (3)
- 419. (Phys. 419) THEORETICAL MECHANICS (3)
- 426. METRIC DIFFERENTIAL GEOMETRY (3)
- 429. GENERAL TOPOLOGY (3)
- 430. ELEMENTARY ALGEBRAIC TOPOLOGY (3)
- 435. BASIC ABSTRACT ALGEBRA (3)
- 436. LINEAR ALGEBRA (3)
- 441. MATRIX ALGEBRA (3)
- 449. ALGEBRAIC GEOMETRY (3)
- 452. FINITE DIFFERENCES (3)
- 453. (Cmp.Sc. 453) NUMERICAL COMPUTATIONS (3)
- 454. (Cmp.Sc. 454) MATRIX COMPUTATIONS (3)
- 457. INTRODUCTION TO MATHEMATICAL LOGIC (3)
- 459. COMPUTABILITY AND UNSOLVABILITY (3)
- 461. (Phys. 461) THEORETICAL MECHANICS (3)
- 462. INTRODUCTION TO SET THEORY (3)
- 465. NUMBER THEORY I (3)
- 466. NUMBER THEORY II (3)
- 470. ALGEBRA FOR TEACHERS (3)
- 471. GEOMETRY FOR TEACHERS (3)
- 472. PROBABILITY FOR TEACHERS (3)
- 480. FOUNDATIONS OF GEOMETRY (3)
- 484. LINEAR PROGRAMS AND RELATED PROBLEMS (3)
- 485. GRAPH THEORY (3)
- 486. MATHEMATICAL THEORY OF GAMES (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

501-502. THEORY OF FUNCTIONS OF A REAL VARIABLE (3 each) Sets, metric spaces, measure and integration,  $L_p$  spaces and other function spaces, differentiation. Prerequisite: Math. 402.

503. FUNCTIONAL ANALYSIS (3:3:0) Theory of Banach and Hilbert spaces, including functionals and operators, and related topics. Prerequisite: Math. 502.

505-506-507. FUNDAMENTALS OF APPLIED MATHEMATICS (3 each) Vector spaces, linear transformations, Fourier and Laplace transforms, distributions, differential operators, integral equations, compact operators, variational methods, partial differential equations. Prerequisite: Math. 401 or 411 or 412.

508. INTEGRAL EQUATIONS (3:3:0) Fredholm and Volterra equations and applications. Prerequisite: Math. 401 or 411 or 412.

509. DISTRIBUTIONS AND GENERALIZED FUNCTIONS (3:3:0) Schwartz-Sobolev theory of distributions, tempered distributions, Fourier transforms, fundamental solutions of ordinary and partial differential equations; applications. Prerequisite: Math. 401 or 412 or 430.
510. CALCULUS OF VARIATIONS AND OPTIMAL CONTROL (3:3:0) Classical and modern theory of the calculus of variations; problems in optimal control. Prerequisite: Math. 401 or 411 or 412.
- 511-512. ORDINARY DIFFERENTIAL EQUATIONS (3 each) Linear spaces and operators, existence and uniqueness of solutions, linear systems. Green's functions, eigenvalue problems — including Fourier series. Prerequisite: Math. 250 or 251 or 411.
513. PARTIAL DIFFERENTIAL EQUATIONS OF MATHEMATICAL PHYSICS I (3:3:0) Methods of solution of selected elliptic, parabolic, and hyperbolic partial differential equations, with reference to physical application. Prerequisite: Math. 411 or 412.
514. PARTIAL DIFFERENTIAL EQUATIONS OF MATHEMATICAL PHYSICS II (3:3:0) Elliptic operators, fundamental solutions, weak and strong derivatives, Sobolev inequalities, Dirichlet problem, equations of evolution, semi-groups. Prerequisite: Math. 513.
516. (Stat. 516) STOCHASTIC PROCESSES (3:3:0) Markov chains; generating functions; limit theorems; continuous time and renewal processes; martingales, submartingales, and supermartingales; diffusion processes; applications. Prerequisite: Math. (Stat.) 416.
517. (Stat. 517-518) PROBABILITY THEORY (3:3:0) Measure theoretic foundation of probability, distribution functions and laws, types of convergence, central limit problem, conditional probability, special topics. Prerequisite: Math. 501.
519. (Stat. 519) ADVANCED TOPICS IN STOCHASTIC PROCESSES (3:3:0) Selected topics in stochastic processes, including Markov and Wiener processes; stochastic integrals, optimization, and control; optimal filtering. Prerequisites: Math. (Stat.) 516, 517.
520. PROJECTIVE GEOMETRY (3:3:0) General study of the subject from the synthetic and analytic standpoint. Prerequisites: Math. 435, 480.
- 521-522. COMPLEX ANALYSIS (3 each) Analytic and meromorphic functions; Riemann's mapping theorem. Prerequisite: Math. 402.
523. THEORY OF SPECIAL FUNCTIONS (3:3:0) Topics include asymptotic expansions; Riemann-Papperitz and Trusdell's F equations; orthogonal polynomials; generating beta, zeta, hypergeometric, Bessel, Legendre, elliptic functions. Prerequisite: Math. 401 or 406 or 521.
524. ADVANCED COMPLEX ANALYSIS (3:3:0) Topics include boundary behavior of analytic functions, bounded analytic functions, conformal mapping, theory of Riemann surfaces. Prerequisite: Math. 522.
525. THEORY OF FUNCTIONS OF SEVERAL COMPLEX VARIABLES (3-6) Topics include fundamental properties of holomorphic functions, complex analytic manifolds, integral representations, Cousin problems. Prerequisite: Math. 522.
526. DIFFERENTIAL GEOMETRY (3:3:0) Manifolds-differentiable structures, tangent spaces, connections, structural equations. Riemannian geometry. Prerequisite: Math. 429.
527. COMPLEX DIFFERENTIAL GEOMETRY (3:3:0) Riemann surfaces, bounded domains, complex manifolds, Kahler manifolds, curvatures, Schwartz lemmas, holomorphic mappings. Prerequisites: Math. 521, 526.
528. UNIFORM SPACES AND FUNCTION SPACES (3:3:0) Uniform spaces, completion, compactifications, function spaces, metrization. Prerequisite: Math. 429.
529. TOPOLOGY I (3:3:0) Topological, product, metric spaces. Compactness, local compactness, connected and locally connected spaces, countability conditions, topology of the plane, fundamental groups.
530. TOPOLOGY II (3:3:0) Homotopy theory, introduction to manifolds, singular homology theory, and the axioms of homology. Prerequisite: Math. 529.
531. ALGEBRAIC TOPOLOGY I (3:3:0) Higher homotopy groups, fibre spaces, fibre bundles, sheaf cohomology, surgery theory. Prerequisite: Math. 530.
532. ALGEBRAIC TOPOLOGY II (3:3:0) Geometric applications of algebraic topology; manifolds, Morse theory, the h-cobordism theorem. Prerequisite: Math. 531.



533-534. LIE THEORY (3 each) Topics selected from theory of topological semigroups, topological groups, lie groups, transformation groups. Prerequisite: Math. 530.

535-536. ALGEBRA (3 each) Permutation groups, Sylow theorems, Jordan-Hölder theorem, polynomial rings, unique factorization domains. Algebraic and transcendental field extensions, Galois theory. Prerequisites: Math. 435 and a course in linear algebra.

537. FIELD THEORY (3:3:0) Finite and infinite algebraic extensions. Cyclotomic fields. Transcendental extensions. Bases of transcendence. Luroth's theorem, ordered fields, valuations. Formally real fields. Prerequisite: Math. 536.

538. COMMUTATIVE ALGEBRA (3:3:0) Topics selected from Noetherian rings and modules, primary decompositions, Dedekind domains and ideal theory, other special types of commutative rings or fields. Prerequisite: Math. 536.

539-540. RING THEORY (3 each) Selected topics including Noetherian and Artinian modules and rings, semisimple rings, Wedderburn theorems, Jacobson radical and density theorem. Prerequisite: Math. 536.

541. LINEAR ALGEBRA (3:3:0) Vector spaces and linear transformations, canonical representations, elementary divisors, and invariant factors. Prerequisite: Math. 436 or 536.

542-543. GROUP THEORY (3 each) Topics selected by instructor from abelian, solvable, and nilpotent groups; finite presentations; free products; group extensions; group representations. Prerequisite: Math. 535.

544. APPLIED ALGEBRA I (3:3:0) Basic algorithms of algebra, application to number theory, group theory, field theory, linear algebra, and combinatorics. Prerequisites: Math. 435, 436, and ability to use a computer.

545. APPLIED ALGEBRA II (3:3:0) Analysis and implementation of various algorithms used in current mathematical research. Prerequisite: Math. 544.

546. SEMIGROUP THEORY AND APPLICATIONS (3:3:0) Basic algebraic properties of semigroups, finite transformation semigroups, free semigroups. Applications to automata theory, formal languages, and combinatorics. Prerequisite: Math. 435 or 535.

547. HOMOLOGICAL ALGEBRA (3:3:0) Modules, diagrams, functors, homology of complexes, resolutions, cohomology of groups, tensor and torsion products. Prerequisite: Math. 536.

548. ADVANCED ALGEBRA (3:3:0) Topics vary depending on instructor and demand. Possible topics are multilinear algebra, tensor products, Brauer group, category theory, and K-theory. Prerequisite: Math. 539.

549. ALGEBRAIC GEOMETRY (3:3:0) Topics may include algebraic curves, the Riemann-Roch theorem, schemes, and sheaf cohomology. Prerequisite: Math. 536.

550. (Cmp.Sc. 550) NUMERICAL ALGEBRA (3:3:0) Zeros of polynomials; iterative solution of linear and nonlinear systems; sparse matrix techniques: eigenvalues and eigenvectors. Prerequisite: Math. (Cmp.Sc.) 454 or Math. 441.

551. (Cmp.Sc. 551) NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS (3:3:0) Methods for initial value and boundary value problems. Stability and convergence analysis, automatic error control, and stiff systems. Prerequisites: Math. (Cmp.Sc.) 453, Math. 411.

552. (Cmp.Sc. 552) NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS (3:3:0) Methods of parabolic, hyperbolic, and elliptic partial differential equations; finite difference and variational methods; splines, finite elements. Prerequisites: Math. 405; or Math. (Cmp.Sc.) 453, 454.

553. (Cmp.Sc. 553) INTRODUCTION TO APPROXIMATION THEORY (3:3:0) Interpolation; remainder theory; approximation of functions; error analysis; orthogonal polynomials; approximation of linear functionals; functional analysis applied to numerical analysis. Prerequisites: Math. 401 and 3 credits of computer science.

554. APPROXIMATION THEORY (3:3:0) Approximation in normed spaces; existence, uniqueness, characterization, computation of best approximations; error bounds; degree of approximation; approximation of linear functionals. Prerequisites: Math. (Cmp.Sc.) 453, Math. 501.

555. THEORY AND TECHNIQUES OF OPTIMIZATION (3:3:0) Minimization of functionals; convexity, duality, penalty; gradient and conjugate gradient methods; quadratic problems; variational inequalities; optimal control, differential game problems. Prerequisites: Math. 405, Math. (Cmp.Sc.) 453, 454.
556. THE FINITE ELEMENT METHOD IN PARTIAL DIFFERENTIAL EQUATIONS (3:3:0) Variational formulations of partial differential equations; algorithms and errors for finite element approximations; isoparametric elements; nonlinear partial differential equations. Prerequisite: Math. 555.
- 557-558. MATHEMATICAL LOGIC AND FOUNDATIONS OF MATHEMATICS I, II (3 each) First-order logic. Completeness and incompleteness theorems of Gödel. Introduction to model theory, axiomatic set theory, computability, and unsolvability. Prerequisites: Math. 457 or consent of instructor (for Math. 557 only); Math. 557 (for Math. 558 only).
559. RECURSION THEORY I (3:3:0) Recursive functions, enumeration theorem, recursion theorem; recursively enumerable sets, the jump operator, arithmetical hierarchy; subrecursive hierarchies, complexity theory; degrees of unsolvability. Prerequisite: Math. 558 or Cmp.Sc. 559.
560. RECURSION THEORY II (3:3:0) Continuation of Math. 559: recursively enumerable sets, degrees of unsolvability, hierarchy theory, inductive definitions, recursion in higher types. Prerequisite: Math. 559.
561. SET THEORY I (3:3:0) Models of set theory, constructible sets, forcing, large cardinals and elementary embeddings; introduction to descriptive set theory; introduction to infinitary combinatorics. Prerequisite: Math. 558.
562. SET THEORY II (3:3:0) Continuation of Math. 561. Large cardinals, indiscernibles, iterated ultrapowers; iterated forcing, infinitary combinatorics, trees; descriptive set theory, the axiom of determinacy. Prerequisite: Math. 561.
563. MODEL THEORY I (3:3:0) Compactness and upward Lowenheim-Skolem theorems, interpolation, and definability; element types, saturation, indiscernibles, omitting types theorems; applications to algebra. Prerequisite: Math. 558.
564. MODEL THEORY II (3:3:0) Continuation of Math. 563. Ultrapowers, categoricity, infinitary logic, stability and superstability; other topics; applications to algebra. Prerequisite: Math. 563.
- 565-566. NUMBER THEORY I AND II (3 each) Congruences, quadratic residues, arithmetic functions, partitions, classical multiplicative ideal theory, valuations and p-adic numbers; primes in arithmetic progression, distribution of primes. Prerequisite: Math. 435 (for Math. 566 only). Prerequisite or concurrent: Math. 521.
567. NUMBER THEORY III (3:3:0) Higher order residues, Fermat's "Last Theorem" for regular primes, formulae for class number of cyclotomic and quadratic extensions, partition congruences. Prerequisite: Math. 566.
568. ALGEBRAIC NUMBER THEORY I (3:3:0) Dedekind rings; cyclotomic and Kummer extensions; valuations; ramification, decomposition, inertial groups; Galois extensions; locally compact groups of number theory. Prerequisites: Math. 536, 566.
569. ALGEBRAIC NUMBER THEORY II (3:3:0) Local and global class field theory; integral quadratic forms; algebraic and arithmetic groups; algebraic function of one variable. Prerequisite: Math. 568.
570. ANALYTIC NUMBER THEORY I (3:3:0) Improvements of the prime number theorem, L-functions and class numbers, asymptotic and arithmetic properties of coefficients of modular forms. Prerequisites: Math. 521, 566.
571. ANALYTIC NUMBER THEORY II (3:3:0) Distribution of primes, analytic number theory in algebraic number fields, transcendental numbers, advanced theory of partitions. Prerequisite: Math. 570.
572. SPECIAL TOPICS IN ALGEBRA (3-12)
573. SPECIAL TOPICS IN APPLIED MATHEMATICS (3-12)
574. TOPICS IN MATHEMATICAL LOGIC AND THE FOUNDATIONS OF MATHEMATICS (3-6)
575. SPECIAL TOPICS IN NUMBER THEORY (3-12)
576. SPECIAL TOPICS IN ANALYSIS (3-12)
578. SPECIAL TOPICS IN TOPOLOGY (3-12)



- 579. (Cmp.Sc. 579) SPECIAL TOPICS IN NUMERICAL ANALYSIS (2-12)
- 580. SPECIAL TOPICS IN GEOMETRY (3-12)
- 587. SPECIAL TOPICS IN COMBINATORICS (3 per semester, maximum of 6) Topics selected from the theories of enumeration and construction of combinatorial structures. Prerequisites: Math. 435, 436, 465.
- 590. COLLOQUIUM (1-3)
- 591-592. MATHEMATICAL SEMINAR (1-6) Selected topics from recent mathematical developments.
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3)

## MATHEMATICS (MATH)

HELMUT E. WEBER, *In Charge of the Graduate Program in Mathematics*  
 King of Prussia Center  
 650 S. Henderson Road  
 King of Prussia, PA 19406  
 215-265-7640

**Degree Conferred:** M.Ed.

### Associate Members of the Graduate Faculty

Robert L. Duncan, M.A. (Penn State) *Associate Professor of Mathematics*  
 Richard E. Llorens, Ph.D. (Penn State) *Professor of Engineering Mechanics*

The program is offered specifically to permit teachers in the area to pursue advanced studies through evening classes while employed in teaching. Courses offered for the program are established and controlled by the resident departments at the University Park Campus.

Further details concerning this program may be obtained by writing directly to the King of Prussia Center.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. An applicant must have a bachelor's degree and have completed 27 credits in mathematics including at least 15 credits at the intermediate level beyond calculus. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

### Degree Requirements

Credit requirements may be satisfied by completing a minimum of 18 credits in approved mathematics courses, a minimum of 6 credits in approved mathematics and science courses, and a minimum of 6 credits in approved education courses. In addition, a term paper is required. All requirements must be met within six years or seven consecutive summers.

## MECHANICAL ENGINEERING (M E)

DONALD R. OLSON, *Head of the Department*  
207 Mechanical Engineering Building  
814-865-2519

**Degrees Conferred:** Ph.D., M.S., M.Eng.

### Senior Members of the Graduate Faculty

Richard G. Cunningham, Ph.D. (Northwestern), P.E. *Professor of Mechanical Engineering*  
Gerard M. Faeth, Ph.D. (Penn State) *Professor of Mechanical Engineering*  
Robert J. Heinsohn, Ph.D. (Michigan State) *Professor of Mechanical Engineering*  
Robert E. Henderson, Ph.D. (Cambridge) *Professor of Mechanical Engineering*  
John J. Henry, Sc.D. (M.I.T.) *Professor of Mechanical Engineering*  
Kenneth K. Kuo, Ph.D. (Princeton) *Professor of Mechanical Engineering*  
Samuel S. Lestz, Ph.D. (Wisconsin) *Professor of Mechanical Engineering*  
Donald R. Olson, D.Eng. (Yale), P.E. *Professor of Mechanical Engineering*  
William H. Park, Ph.D. (Cornell) *Professor of Mechanical Engineering*  
Gerhard Reethof, Sc.D. (M.I.T.) *Professor of Mechanical Engineering*  
Frank W. Schmidt, Ph.D. (Wisconsin) *Professor of Mechanical Engineering*  
J. Lowen Shearer, Sc.D. (M.I.T.), P.E. *Professor of Mechanical Engineering*  
James C. Wambold, Ph.D. (New Mexico) *Professor of Mechanical Engineering*  
Ralph L. Webb, Ph.D. (Minnesota) *Professor of Mechanical Engineering*  
Carl H. Wolgemuth, Ph.D. (Ohio State) *Professor of Mechanical Engineering*

### Associate Members of the Graduate Faculty

Gordon F. Hayhoe, Ph.D. (Cranfield Inst. of Tech.) *Assistant Professor of Mechanical Engineering*  
Robert R. Huber, Ph.D. (Penn State) *Assistant Professor of Mechanical Engineering*  
Thomas G. Hughes, Ph.D. (Penn State) *Research Associate at Applied Research Laboratory*  
Anil K. Kulkarni, Ph.D. (Brown) *Assistant Professor of Mechanical Engineering*  
Oliver H. McDaniel, Ph.D. (Penn State) *Research Associate, Mechanical Engineering*  
Charles L. Merkle, Ph.D. (Princeton) *Assistant Professor of Mechanical Engineering*  
Ashok Midha, Ph.D. (Minnesota) *Associate Professor of Mechanical Engineering*  
James E. O'Brien, Ph.D. (Minnesota) *Assistant Professor of Mechanical Engineering*  
Richard B. Smith, Ph.D. (Penn State) *Research Associate at Applied Research Laboratory*  
H. Joseph Sommer III, Ph.D. (Illinois) *Assistant Professor of Mechanical Engineering*  
Stephen R. Turns, Ph.D. (Wisconsin) *Assistant Professor of Mechanical Engineering*  
Savas Yavuzkurt, Ph.D. (Stanford) *Assistant Professor of Mechanical Engineering*

Graduate programs and research facilities are available in thermodynamics and combustion, heat transfer, fluid mechanics, dynamic system analysis, mechanical design, and energy systems. Air pollution control, automotive safety, designing for noise control and for reliability also provide many research and design opportunities.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

A student working toward an M.S. degree may choose one of the following options: (1) a minimum of 24 course credits plus 6 thesis credits (M.E. 600) culminating in the submission of a thesis to the Graduate School; (2) a minimum of 30 course credits plus a technical report; or (3) a minimum of 30 course credits plus submission of a Ph.D. thesis research proposal, provided the student has passed the candidacy examination.

The entering student must hold a bachelor's degree in engineering or physical science. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.



**Degree Requirements**

The communication and foreign language requirement for the Ph.D. degree may be satisfied by an in-depth study of one foreign language (6 credits), by taking two or more courses (minimum of 6 credits) of a nontechnical nature in a single area of study appropriate and related to the student's career orientation, or by taking an advanced technical writing course (Engl. 418 — 3 credits and Engl. 496. — 1 credit) and presenting a formal proposal for thesis research (M.E. 596 — 2 credits) to the doctoral committee.

**Student Aids**

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

**W. S. ELLIOTT FELLOWSHIP** — Available to a graduate student who is a graduate of The Pennsylvania State University and is interested in engineering research; stipend variable. Apply to Office of the Dean, College of Engineering, 101 Hammond Building.

**TAU BETA PI FELLOWSHIP** — Open to any member of Tau Beta Pi, the engineering honor society, for a year of advanced study. Up to eighteen awards of \$3,500 each are available. Applications and information may be obtained from the Office of the Dean, College of Engineering, 101 Hammond Building. Application deadline is February 15.

**MECHANICAL ENGINEERING (M E)**

- 400H. HONORS THESIS (1-3)
- 403. ROCKET PROPULSION (3)
- 405. AIR POLLUTION CONTROL SYSTEMS (3)
- 409. GAS TURBINES (3)
- 410. POWER PLANTS (3)
- 411. REFRIGERATION AND AIR CONDITIONING (3)
- 412. HEAT TRANSFER (3)
- 413. INTERNAL COMBUSTION ENGINES (3)
- 414. ENGINEERING ANALYSIS OF THERMAL SYSTEMS (3)
- 415. ENGINEERING ANALYSIS FOR MECHANICAL DESIGN (3)
- 417. THEORY OF ENGINEERING INSTRUMENTS (3)
- 418. PRINCIPLES OF TURBOMACHINERY (3)
- 420. HEAT-EXCHANGER DESIGN (3)
- 421. (Aersp. 421) INTERMEDIATE VISCOUS FLOW (3)
- 440. MODELING OF DYNAMIC SYSTEMS (3)
- 450. DESIGN OF MACHINE TOOLS (3)
- 451. ADVANCED MACHINE DESIGN PROBLEMS (3)
- 452. DESIGN ANALYSIS (3)
- 454. ADVANCED MACHINE DYNAMICS (3)
- 455. AUTOMATIC CONTROL SYSTEMS (3)
- 456. (I.E. 456) INDUSTRIAL ROBOT APPLICATIONS (3)
- 458. NOISE CONTROL IN MACHINERY (3)
- 460. RELIABILITY CONCEPTS IN DESIGN (3)
- 470. FUNDAMENTALS OF AIR POLLUTION (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

503. THERMODYNAMIC PROCESS ANALYSIS (3) Development of equations governing separate processes in complete machines to give basic system parameters and characteristics; transient processes; irreversible effects.

504. ADVANCED ENGINEERING THERMODYNAMICS (3-6) Pure and applied thermodynamics including its application to advanced engineering problems; collateral reading and discussion of the classical works on the subject.

505. DESIGN OF AIR POLLUTION CONTROL SYSTEMS (3) Advanced principles of design drawn from professional literature, including mechanical collectors, electrostatic precipitators, filters, scrubbers, and industrial ventilation systems. Prerequisite: M.E. 405.

512. HEAT TRANSFER — CONDUCTION (3) One- and two-dimensional conduction heat transfer for steady state and transient systems with varying boundary conditions.
513. HEAT TRANSFER — CONVECTION (3) Laminar and turbulent flow heat transfer in natural and forced convection systems.
514. HEAT TRANSFER — RADIATION (3) Thermal radiation fundamentals; specular and diffuse systems; differential and integral methods; numerical techniques; industrial applications.
515. TWO-PHASE HEAT TRANSFER (3) Heat transfer processes involving evaporation, boiling, and condensation.
516. COMBUSTION IN PROPULSION SYSTEMS (3) Theoretical formulations and methods of solution of engineering problems and physical processes in chemical propulsion systems.
517. TECHNIQUES FOR HEAT TRANSFER ENHANCEMENT (3) Study of advanced concepts in convective and two-phase heat transfer, with emphasis on techniques of heat transfer enhancement. Prerequisites: M.E. 513, 515.
518. ANALYSIS OF HEAT EXCHANGER EQUIPMENT (3) Application of theoretical fundamentals to the design of heat exchange equipment, and the analysis of simultaneous heat and mass transfer processes. Prerequisite: M.E. 513 or 515.
519. COMPRESSIBLE FLUID FLOW (2-4) Two-dimensional subsonic flow; similarity rules; theory of characteristics; supersonic and hypersonic flows; nonsteady flow; oblique shock waves.
521. ELECTROMAGNETIC AND THERMODYNAMIC FLOW SYSTEMS (3) Thermodynamic equations for flow of reacting and nonreacting fluids in electromagnetic fields; applications to engineering problems.
522. BOUNDARY LAYER AND SEPARATED FLOWS (3) Behavior of viscous fluids, with emphasis on boundary layer and separation effects in internal flow.
526. (Aersp. 526) COMPUTATIONAL METHODS FOR SHEAR LAYERS (3) Study of numerical solution methods for steady and unsteady laminar or turbulent boundary-layer equations in two and three dimensions. Prerequisite: M.E. 540 or Aersp. 423.
527. (Aersp. 527) COMPUTATIONAL METHODS IN TRANSONIC FLOW (3) Numerical solution of partial differential equations of mixed type, with emphasis on transonic flows and separating boundary layers. Prerequisite: M.E. 540 or Aersp. 423.
540. NUMERICAL SOLUTIONS APPLIED TO HEAT TRANSFER AND FLUID MECHANICS PROBLEMS (3) Application of finite difference methods to the study of potential and viscous flows and conduction and convection heat transfer.
552. ADVANCED DYNAMICS OF MACHINES (3-6) Linear and torsional vibrations in and balancing of rotating and reciprocating machinery; exact analysis of stresses produced by these and other dynamic forces in machine parts. Prerequisites: E.Mch. 12, M.E. 54.
555. AUTOMATIC CONTROL SYSTEMS (3) Advanced problems and techniques in the design of automatic control systems with emphasis on stability, controller design, and optimum performance. Prerequisite: M.E. 455.
557. MECHANISM SYNTHESIS (3) Geometrical and algebraic methods for synthesizing planar and spatial mechanisms, dynamics of spatial mechanism.
558. FLUID CONTROL SYSTEMS (2) Modeling fluid system dynamic performance, experimental determination of the actual behavior, and comparison of predicted behavior with actual behavior. Prerequisite: M.E. 455.
562. SIMULATION OF MECHANICAL SYSTEMS (3) Introduces computational fundamentals, including digital logic; programming language, basic numerical analysis and data processing, as applied to mechanical simulation techniques. Prerequisites: M.E. 54, 66.
571. AIR POLLUTION SEMINARS (1-2) Weekly seminars featuring the contributions of many different disciplines to the solution of air pollution and other environmental problems.
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)



## METALLURGY (METAL)

JOHN H. HOKE, *In Charge of Graduate Programs in Metallurgy*  
209 Steidle Building  
814-865-5446

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

William R. Bitler, Ph.D. (Carnegie Tech.) *Professor of Metallurgy*  
John H. Hoke, D. Eng. (Johns Hopkins) *Professor of Metallurgy*  
Paul R. Howell, Ph.D. (Cambridge) *Associate Professor of Metallurgy*  
Arnulf I. Muan, Ph.D. (Penn State) *Professor of Geochemistry*  
Kwadwo Osseo-Asare, Ph.D. (California) *Associate Professor of Metallurgy*  
Howard W. Pickering, Ph.D. (Ohio State) *Professor of Metallurgy*  
Earle R. Ryba, Ph.D. (Iowa State) *Associate Professor of Metallurgy*  
George Simkovich, Ph.D. (Penn State) *Professor of Metallurgy*  
Peter A. Thrower, Ph.D. (Cambridge) *Associate Professor of Materials Science*

### Associate Members of the Graduate Faculty

Tarasankar Deb Roy, Ph.D. (Inst. of Sci., Bangalore) *Assistant Professor of Metallurgy*  
W. Murray Small, Ph.D. (Michigan) *Associate Professor of Metallurgy*

This program is one of the options in which a graduate student in the Department of Materials Science and Engineering can receive an advanced degree. Suitable preparation for graduate study in this program may be obtained in various science and engineering majors as well as metallurgy. A student may specialize, through both course work and research, in the science and engineering aspects of chemical, physical, or mechanical metallurgy.

Faculty expertise and research facilities permit particular emphasis in the areas of electron microscopy, oxidation, corrosion, hydrometallurgy, and pyrometallurgy. Courses relevant to the Metallurgy program, laboratory facilities, and faculty interaction with other departments broaden the scope of program possibilities.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

### Master's Degree Requirements

Those students entering from a major other than metallurgy must take or be excused from a listed 6 credits of deficiency courses. All graduate students are expected to contribute to the instructional program. Mat.Sc. 501 and 503 are required courses. A thesis and thesis examination are part of the degree requirements.

### Doctoral Degree Requirements

Usually all students who do not have an acceptable M.S. degree initially must work toward that degree. A student will be permitted to proceed toward the Ph.D. degree without first earning the M.S. degree only by faculty decision.

Those students entering from a major other than metallurgy must take or be excused by the faculty from a listed 10 credits of deficiency courses.

The communication and foreign language requirement for the Ph.D. may be satisfied by passing with a B grade or better 9 credits at the 400 or 500 level in computer science and statistics.

All graduate students are expected to contribute to the instructional program.

A candidacy examination (written), a minor or general studies (15 credits minimum) program, a comprehensive examination (written and oral), and a thesis and thesis examination also are required.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid

## METALLURGY

described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

ARCO FELLOWSHIPS (2) — Available to graduate students in Metallurgy; stipend \$6,768.

NATIONAL STEEL FELLOWSHIP — Available to graduate students in Metallurgy; stipend \$6,768.

KENNAMETAL FELLOWSHIP — Available to graduate students in Metallurgy; stipend \$6,768.

### METALLURGY (METAL)

- 400. CORROSION FORMS AND PREVENTION (3)
- 401. METALLURGICAL PROCESSES AND KINETICS (3)
- 402. CORROSION ENGINEERING (3)
- 404. DESIGN OF PYROMETALLURGICAL SYSTEMS (3)
- 405. PHYSICAL METALLURGY (3)
- 406. ALLOY SYSTEMS (3)
- 407. SOLIDIFICATION PROCESSING (3)
- 408. DEFORMATIONAL PROCESSING (3)
- 410. METALLURGICAL INVESTIGATIONS AND DESIGN (1-6)
- 412. SOLID-STATE METALLURGY (3)
- 414. EXTRACTIVE METALLURGY LABORATORY (1)
- 416. HYDROMETALLURGY LABORATORY (1)
- 426. (Mn.Pr. 426) HYDROMETALLURGY (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 501. METALLURGICAL PROBLEMS (1-6 per semester) Independent study of special problems in metallurgy.
- 505. OXIDATION OF METALS (3) The course will cover high-temperature oxidation of metals and alloys including Wagner's theories of internal oxidation. Prerequisite: Chem. 451. *Simkovich*
- 507. (Mn.Pr. 507) HYDROMETALLURGICAL PROCESSING (3) Fundamental physico-chemical factors underlying the aqueous extraction and recovery of metals and nonmetals from ores, minerals, and scrap metal. Prerequisite: Metal. (Mn.Pr.) 426. *Osseo-Asare*
- 508. KINETICS OF PHASE TRANSFORMATIONS (3) Application of statistical mechanics and absolute rate theory to kinetics of phase transformations, including diffusion, nucleation, and growth rates. *Bitler*
- 509. INTRODUCTORY THEORETICAL PHYSICAL METALLURGY (3) Quantum mechanics and its application to solid-state theory; introduction of Schroedinger's equation, its solutions, free-electron model, band model. *Bitler*
- 510. MAGNETIC AND TRANSPORT PROPERTIES OF MATERIALS (3) Treatment of the magnetic and transport properties of solids by quantum mechanics with applications to practical alloy development. Prerequisite: Metal. 509. *Bitler*
- 513. ADVANCED CHEMICAL METALLURGY I (3) Application of thermodynamics and kinetics to the heterogeneous metallurgical processes of oxidation, reduction, smelting, and refining. Prerequisites: Chem. 452, Metal. 402, 404. *Simkovich*
- 514. DISLOCATION THEORY (3) Self and interaction energies of dislocations and other defect structures; dislocation motions and their relation to mechanical properties. *Bitler*
- 515. CORROSION OF METALS (3) Phenomena and theories of metallic corrosion; principles of alloy selection for engineering and structural uses in corrosive environments. *Pickering*
- 516. FLOW AND FRACTURE OF SOLIDS (3) Phenomenological and theoretical treatment of flow and fracture in solids. Prerequisite: Metal. 514.
- 517. METAL ELECTRODE REACTIONS (2) Evaluation of electrode reaction mechanisms at metal/water and metal/oxide/water interfaces relevant to corrosion and industrial electrolytic processes. Prerequisites: Chem. 451, 452. *Pickering*
- 519. ADVANCED CHEMICAL METALLURGY II (3) Application of thermodynamics and kinetics to precipitation of nonmetallic and metallic phases from liquid and solid metals at elevated temperatures. Prerequisite: Metal. 513. *Small*



520. **FOUNDRY METALLURGY (3)** Physical-chemical considerations of the liquid state, solidification, and the solid state as applied to casting of metals and alloys. Prerequisite: Metal. 513.

522. **SOLID-PHASE REACTIONS IN METALS (3)** Mechanisms and rate-determining factors in solid-phase reactions in metals; diffusion processes, nucleation theory, precipitations from solid solution, eutectoid decomposition and order-disorder phenomena. Prerequisite: Metal. 508. *Bitler*

535. (E.Mch. 535) **CRYSTAL DEFECTS AND MECHANICAL RESPONSE (3)** Mechanical responses of crystalline solids containing point, line, and interfacial defects; elastic and plastic responses. Prerequisite: Metal. 514 or E.Sc. 414H. *Queeney*

602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)**

*NOTE: Courses in introductory thermodynamics and kinetics of metals, and the use of X-ray diffraction, electron microscopy, and spectroscopy in metallurgical studies are listed under Materials Science.*

## METEOROLOGY (METEO)

JOHN A. DUTTON, *Head of the Department*  
503 Walker Building  
814-865-0478

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Alfred K. Blackadar, Ph.D. (N.Y.U.) *Professor of Meteorology*  
John J. Cahir, Ph.D. (Penn State) *Professor of Meteorology*  
Toby N. Carlson, Ph.D. (Imperial College, London) *Professor of Meteorology*  
Rosa G. de Pena, Ph.D. (Buenos Aires) *Professor of Meteorology*  
John A. Dutton, Ph.D. (Wisconsin) *Professor of Meteorology*  
Alistair B. Fraser, Ph.D. (Imperial College, London) *Professor of Meteorology*  
Charles L. Hosler, Ph.D. (Penn State) *Professor of Meteorology*  
John J. Olivero, Ph.D. (Michigan) *Associate Professor of Meteorology*  
Hans A. Panofsky, Ph.D. (California, Berkeley) *Evan Pugh Research Professor Emeritus of Atmospheric Sciences*  
Dennis W. Thomson, Ph.D. (Wisconsin) *Professor of Meteorology*

### Associate Members of the Graduate Faculty

Bruce A. Albrecht, Ph.D. (Colorado State) *Assistant Professor of Meteorology*  
Craig F. Bohren, Ph.D. (Arizona) *Associate Professor of Meteorology*  
John H. E. Clark, Ph.D. (Florida State) *Associate Professor of Meteorology*  
Gregory S. Forbes, Ph.D. (Chicago) *Assistant Professor of Meteorology*  
J. Michael Fritsch, Ph.D. (Colorado State) *Associate Professor of Meteorology*  
Hampton N. Shirer, Ph.D. (Penn State) *Assistant Professor of Meteorology*  
Thomas T. Warner, Ph.D. (Penn State) *Assistant Professor of Meteorology*

The graduate program embraces topics that span atmospheric processes from those of the planetary boundary layer to those of the upper atmosphere, that encompass phenomena with molecular to planetary dimensions, and that range from practical to theoretical significance. The program attempts to develop and integrate approaches based on observational, computational, and analytical techniques.

The major interests of the faculty and graduate students center on (1) analysis, modeling, and prediction of the evolution of synoptic scale and mesoscale weather systems, particularly those of significant impact on human activities; (2) observation and theoretical study of processes related to transmission of radiation through the atmosphere, including remote sensing through use of electromagnetic or acoustic systems; (3) theoretical study of atmospheric dynamics on a variety of scales, including nonlinear phenomena of atmospheric circulation and climate, boundary layer physics, turbulence, and convective systems.

The department encourages interdisciplinary studies and is expanding its programs in agricultural meteorology, biometeorology, environmental quality, and mathematical study of fluid dynamical systems.

## Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in the program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Requirements for admission include mathematics through differential equations and one year of college physics. Undergraduate study of meteorology is not required for admission. Special programs are available to encourage the graduate study of meteorology by all students with strong backgrounds in mathematics, physics, or engineering. Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

## Master's Degree Requirements

The Master of Science degree program comprises instructional and research components. Proficiency in the fundamental concepts of synoptic, dynamic, and physical meteorology is attained in a core curriculum, if not already demonstrated by undergraduate achievements. The degree is offered with both thesis and research paper options.

## Doctoral Degree Requirements

Studies for the Ph.D. degree are designed to accommodate the interests and capabilities of the candidate by a doctoral committee, which also administers comprehensive and final examinations.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of German, Russian, or other appropriate language.

## Other Relevant Information

The program differentiates between instruction and research topics appropriate for M.S. students seeking positions of advanced responsibility in government or industry, those appropriate for M.S. students anticipating further study, and those appropriate for Ph.D. candidates who will work in advanced research laboratories or academic institutions.

## Student Aids

Graduate assistantships available through this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin. Most graduate students are supported with teaching or research assistantships.

## METEOROLOGY (METEO)

- 401. INTRODUCTION TO DYNAMIC AND SYNOPTIC METEOROLOGY (3)
- 402. INTRODUCTORY PHYSICAL METEOROLOGY (3)
- 411. SYNOPTIC METEOROLOGY LABORATORY (4)
- 411H. SYNOPTIC METEOROLOGY LABORATORY HONORS (4)
- 412. ADVANCED SYNOPTIC ANALYTICAL TECHNIQUES (3)
- 414. MESOSCALE ANALYSIS AND FORECASTING (3)
- 415. FORECASTING PRACTICUM (3)
- 421. DYNAMIC METEOROLOGY I (3)
- 421H. DYNAMIC METEOROLOGY HONORS (3)
- 422. DYNAMIC METEOROLOGY II (3)
- 423. FOUNDATIONS OF ATMOSPHERIC PREDICTION (3)
- 431. ATMOSPHERIC THERMODYNAMICS (3)
- 432. ATMOSPHERIC CHEMISTRY AND PHYSICS OF CLOUDS (3)
- 435. RADIATIVE TRANSFER (3)
- 451. ELEMENTS OF PHYSICAL OCEANOGRAPHY (3)
- 452. TROPICAL METEOROLOGY (3)
- 454. INTRODUCTION TO MICROMETEOROLOGY (3)
- 461. THEORY OF METEOROLOGICAL INSTRUMENTS (3)
- 465. MIDDLE ATMOSPHERE METEOROLOGY (3)
- 471. OBSERVING METEOROLOGICAL PHENOMENA (3)



- 472. TOPICS IN CLIMATOLOGY (3)
- 474. APPLICATIONS OF STATISTICS TO METEOROLOGY (3)
- 476. (Geosc. 402) NATURAL DISASTERS SEMINAR (2)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 507. DYNAMIC OCEANOGRAPHY (2) Physical properties of sea water; heat balance of the oceans; theory and observations of ocean currents, waves, and tides.
- 512. ADVANCED METEOROLOGICAL ANALYSIS (3) Graduate version of topics covered in Meteo. 412. Prerequisite: Meteo. 411H.
- 522. DYNAMIC METEOROLOGY (3) Graduate version of topics covered in Meteo. 422. Prerequisite: Meteo. 421H.
- 525. THEORY OF ATMOSPHERIC MOTIONS (3) Kinematic concepts, axiomatic basis of the equations of motion, dimensional analysis, approximate systems, stability analysis, and nonlinear dynamics. Prerequisite: Meteo. 522.
- 526. NUMERICAL WEATHER PREDICTION (3) Finite difference and spectral methods, barotropic and baroclinic models, filtered and primitive equation models, synoptic-scale and mesoscale models. Prerequisites: Meteo. 422; 522.
- 527. ATMOSPHERIC WAVE MOTION (3) From classical and physical hydrodynamics to the numerical prediction of wave motion in a baroclinic atmosphere. Prerequisite: Meteo. 525.
- 528. ANALYTICAL ATMOSPHERIC DYNAMICS (3) Conservation principles, energy conversion processes, dynamics in phase space, introduction to metamodeling. Prerequisite: Meteo. 525.
- 532. CHEMISTRY OF THE ATMOSPHERE (2) Fundamental knowledge of chemical characteristics of atmospheric components and transformations, in connection with cloud microphysics, circulation, and air pollution. Prerequisite: 3 credits in chemistry.
- 533. CLOUD PHYSICS (2) Current theories on phase changes in clouds and mechanisms responsible for precipitation; techniques of cloud modification and control.
- 536. INDIRECT ATMOSPHERIC PROBING (3) Analysis and description of measurements made with radar and bistatic radio; optical and acoustic systems used for indirect atmospheric sounding.
- 554. ATMOSPHERIC TURBULENCE (3) Atmospheric diffusion, heat conduction, friction, and evaporation; statistical properties of turbulence.
- 555. ATMOSPHERIC DIFFUSION (2-3) Dispersion of atmospheric contaminants; experiments, theory, and practical implications for air pollution problems. Prerequisite: 3 credits in statistics.
- 561. CHEMISTRY OF THE ATMOSPHERE (2) Fundamental knowledge of chemical characteristics of atmospheric components and transformations, in connection with cloud microphysics, circulation, and air pollution. Prerequisite: 3 credits in chemistry.
- 565. PHYSICS OF THE UPPER ATMOSPHERE (3) Graduate version of material that is covered in Meteo. 465. Prerequisites: Meteo. 421, 431.
- 572. THEORETICAL CLIMATOLOGY (2) Theory of latitudinal, annual, and diurnal temperature changes; theories of climatic changes, microclimate.
- 573. BIOCLIMATOLOGY (3) Climatic phenomena in their relation to life.
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in meteorological studies are listed under Materials Science.

## MICROBIOLOGY (MICRB)

EDWIN V. GAFFNEY, *In Charge of Graduate Programs in Microbiology*  
S-306 Frear Building  
814-863-2093

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Lester E. Casida, Ph.D. (Wisconsin) *Professor of Microbiology*  
John J. Docherty, Ph.D. (Arizona) *Associate Professor of Microbiology*  
Edwin V. Gaffney, Ph.D. (Catholic) *Associate Professor of Microbiology and Cell Biology*  
Christine F. Pootjes, Ph.D. (Rutgers) *Associate Professor of Microbiology*  
Stanley E. Stevens, Ph.D. (Texas) *Associate Professor of Microbiology*  
Daniel R. Tershak, Ph.D. (Yale) *Associate Professor of Microbiology*  
Leonard N. Zimmerman, Ph.D. (Cornell) *Professor of Bacteriology*

### Associate Members of the Graduate Faculty

Donald A. Bryant, Ph.D. (U.C.L.A.) *Assistant Professor of Microbiology*  
Richard J. Frisque, Ph.D. (Wisconsin) *Assistant Professor of Microbiology*  
Andrea M. Mastro, Ph.D. (Penn State) *Assistant Professor of Microbiology and Cell Biology*  
Steven B. Mizel, Ph.D. (Stanford) *Associate Professor of Immunology*  
Ronald D. Porter, Ph.D. (Duke) *Assistant Professor of Microbiology and Molecular Genetics*

The major goal of the program is to train students for independent research and teaching in microbiology. Opportunities for study are available in bacteriology, cell biology, virology, and immunology. Among current areas of research are included bacterial ecology, genetics, and physiology; photosynthesis; chemical and pathogenic properties of both bacterial and animal viruses; viral and tumor immunology; and cancer biology. Cooperative research with other programs is encouraged.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Applicants to the program are expected to have taken courses in biology, general analytical and organic chemistry, calculus, general physics, and microbiology. Admission is competitive and based on evaluation by the admissions committee of the applicant's undergraduate transcript, Graduate Record Examination scores, and personal recommendations. The best-qualified applicants will be accepted up to the number of assistantships available.

### Degree Requirements

All students are required to pass a written qualifying examination at the end of their first year of graduate study. Students also are expected to begin a research project by the end of their first year of study, after selecting a faculty adviser. Students may earn a master's degree in the course of the Ph.D. work or may bypass the master's degree. The master's program requires a minimum of 30 credits, along with preparation and defense of a research thesis, and usually takes two years to complete. Advancement to Ph.D. candidacy is decided on the basis of course and research performance, in addition to a written and oral examination. A comprehensive oral examination and a thesis defense are integral parts of the Ph.D. program. The Ph.D. usually requires four years. All students are required to participate as teaching assistants in undergraduate laboratories as part of their training.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## MICROBIOLOGY (MICRB)

- 400. INTRODUCTORY ENVIRONMENTAL MICROBIOLOGY (2)
- 401. MICROBIAL PHYSIOLOGY AND STRUCTURE (3)



- 408. LABORATORY INSTRUCTIONAL PRACTICE (1-2)
- 410. PRINCIPLES OF IMMUNOLOGY (2)
- 411. SURVEY OF MICROBIOLOGY (1 per semester)
- 412. MEDICAL MICROBIOLOGY (3)
- 413. MICROBIAL SOIL ECOLOGY (2)
- 414. FOOD MICROBIOLOGY (2)
- 415. BACTERIAL AND ANIMAL VIRUSES (3)
- 416. INDUSTRIAL MICROBIOLOGY (2)
- 419. PHARMACOLOGY AND TOXICOLOGY (2)
- 421. LABORATORY OF GENERAL AND APPLIED MICROBIOLOGY (2)
- 422. PRACTICAL MEDICAL MICROBIOLOGY (2)
- 450. (M.C.B. 450) MICROBIAL/MOLECULAR GENETICS (2)
- 476. THE PHOTOSYNTHETIC PROCESS (3)
- 478. THE BIOLOGY OF CANCER CELLS (2)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 501. SEMINAR (1 per semester) Reports on current fields of research.
- 502. MICROBIOLOGICAL METHODS (1-6) Practice in special laboratory techniques of modern microbiology.
- 503. MICROBIAL PHYSIOLOGY (2 per semester, maximum of 4) Modern concepts in physiology and structure of microorganisms. Prerequisites: 6 credits of biochemistry.
- 504. VIROLOGY (2 per semester, maximum of 4) Emphasis on current research. Prerequisites: 6 credits in biochemistry.
- 505. (M.C.B. 505) MICROBIAL GENETICS (2 per semester, maximum of 4) Modern concepts in the genetics of microorganisms. Prerequisite: Micrb. 450.
- 506. CELL BIOLOGY (2 per semester, maximum of 4) Emphasis on areas of current research with eucaryotic cells. Prerequisites: 6 credits in biochemistry, 3 credits in cell biology.
- 507. IMMUNOLOGY (2 per semester, maximum of 4) Discussions of the modern concepts in immunology. Emphasis on areas of current interest. Prerequisites: Micrb. 410; 6 credits in biochemistry.
- 529. (C.E. 579) AQUATIC MICROBIOLOGY (3) Ecology and physiology of microorganisms of inland waters, estuaries, and oceans; microbiology of wastewater treatment. Prerequisite: introductory microbiology.
- 590. COLLOQUIUM (1-3)
- 597. SPECIAL TOPICS (1-9)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## MICROBIOLOGY (MICRO)

FRED RAPP, *Chairman of the Department*  
 The Milton S. Hershey Medical Center  
 Hershey, PA 17033  
 717-534-8253

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Gerald L. Bartlett, M.D. (Washington, Seattle); Ph.D. (Pennsylvania) *Associate Professor of Pathology and Microbiology*  
 Richard W. Hyman, Ph.D. (Cal. Tech.) *Professor of Microbiology*  
 Harriet C. Isom, Ph.D. (Illinois) *Associate Professor of Microbiology*  
 John W. Kreider, M.D. (Pennsylvania) *Professor of Pathology and Microbiology*  
 Fred Rapp, Ph.D. (Southern California) *Professor of Microbiology*  
 M. Judith Tevethia, Ph.D. (Michigan State) *Associate Professor of Microbiology*  
 Satvir S. Tevethia, B.V.Sc. (Agra-India); Ph.D. (Michigan State) *Professor of Microbiology*

### Associate Members of the Graduate Faculty

Mary K. Howett, Ph.D. (Pennsylvania) Assistant Professor of Microbiology

Allan Lipton, M.D. (N.Y.U.) Professor of Medicine and Microbiology

Ernest D. Márquez, Ph.D. (Southern California) Associate Professor of Microbiology

Fred R. Sattler, M.D. (Southern California) Assistant Professor of Medicine and Microbiology

David J. Spector, Ph.D. (Pennsylvania) Assistant Professor of Microbiology

Richard B. Tenser, M.D. (S.U.N.Y., Upstate) Associate Professor of Medicine and Microbiology

Brian L. Wigdahl, Ph.D. (Medical College, Wisconsin) Assistant Professor of Microbiology

This program is oriented toward the study of viruses and includes programs in viral oncology, viral genetics, tumor immunology, virus gene expression, and virus latency. The molecular biology of eucaryotic systems is an additional focus.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Qualified students with undergraduate preparation in either the biological, biochemical, or physical sciences may apply. An adequate background in biology, chemistry, and mathematics and an overall grade-point average of 3.00 or better are required.

The best-qualified applicants will be accepted on a space-available basis. Formal applications should contain two letters of recommendation and a brief personal essay summarizing the background and professional goals of the applicant.

### Degree Requirements

The communication and foreign language requirement may be satisfied by demonstrating competence in a foreign language, such as French, German, or Russian. Alternatively, courses which enhance communication or mathematical skills can be substituted for the foreign language requirement.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## MICROBIOLOGY (MICRB)

550. MEDICAL MICROBIOLOGY (4) Principles of medical microbiology: host-parasite relationships; structure and function of viruses, bacteria, and fungi as agents causing human disease.

551. MEDICAL MICROBIOLOGY (2) Principles of medical microbiology: host-parasite relationships; structure and function of viruses, bacteria, and fungi as agents causing human disease. Prerequisite: Micrb. 550.

552. MEDICAL MICROBIOLOGY LABORATORY (1) Laboratory exercises to augment Micrb. 551. Laboratory tests used to characterize microorganisms and to aid in diagnosis of disease. Concurrent: Micrb. 551.

553. SCIENCE OF VIROLOGY (3) Replication of viruses and effect on host, including transfer of genetic information, immunology, and oncogenic properties of viruses.

554. PRINCIPLES OF IMMUNOLOGY (2) Study of immune response. Nature of antigens, structure, function of antibodies, hypersensitivity, transplantation and tumor immunology, autoimmunity, and immunosuppression.

555. MICROBIAL PHYSIOLOGY AND METABOLISM (3) Physiology and comparative biochemistry of microorganisms, especially human pathogens. Regulatory mechanisms, energy metabolism, and other topics essential for cell replication.

556. MOLECULAR GENETICS (3) Structure, synthesis, and function of DNA, RNA, and proteins. Emphasis on gene structure and function in the eucaryotic cell.



557. **ELECTRON MICROSCOPY (3)** The application of electron microscopy to microbiology, including specimen preparation, use of the electron microscope, and photography. Prerequisites: admission to the medical or graduate program and permission of instructor.
558. **MEDICAL PARASITOLOGY (2)** Basic information on protozoa, helminths, arthropods, and mollusks involved in the causation of human diseases.
559. **EPIDEMIOLOGY (2)** Provides information on epidemiology — the study of factors that affect occurrence and course of disease in a population.
572. **LITERATURE REPORTS (1 per semester)** Weekly analysis of current literature in microbiology.
590. **COLLOQUIUM (1-3)**
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**

## MINERAL ECONOMICS (MN EC)

RICHARD L. GORDON, *In Charge of Graduate Programs in Mineral Economics*  
221 Walker Building  
814-865-2549

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Richard L. Gordon, Ph.D. (M.I.T.) *Professor of Mineral Economics*  
George H. K. Schenck, Ph.D. (Penn State) *Associate Professor of Mineral Economics*  
John E. Tilton, Ph.D. (Yale) *Professor of Mineral Economics*  
William A. Vogely, Ph.D. (Princeton) *Professor of Mineral Economics*

The program in Mineral Economics prepares students in the application of economic analysis to mineral industries problems, particularly those relevant to long-term policy development by industry and government. Students may work in such areas as commodity analysis (energy, metals, or nonmetals); resource economics (mineral policy or area studies); industrial economics (administration, market research, or financial matters); geostatistical and economic analysis of exploration and exploitation problems; or operations research and statistics (resource allocation, forecasting, or decision making).

The enrollment is kept at levels that insure that students work closely on their research with the faculty and can interact regularly with each other. The training usually leads to work in industries concerned with the extraction, processing, or use of minerals; consulting firms; and government agencies. However, opportunities also exist for assuming academic positions.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. By approval of the dean of the Graduate School, scores on the Graduate Management Achievement Test (GMAT) can be substituted for the GRE by applicants to this program. Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

The program is designed to accommodate students with either a science and engineering or a social science background. Separate admissions requirements are maintained for the two groups. Requirements for admission for those with science or engineering backgrounds are 24 credits in chemistry, physics, mathematics, or statistics; 12 in the earth sciences; 9 in economics, mineral economics, commerce, business administration, or industrial management; and 6 in engineering subjects. Those with social science backgrounds should have 12 credits in economics, mineral economics, and business administration; 6 in geological sciences; and 9 in mathematics and statistics.

A prior master's degree is not required for admission to the Ph.D. program. Students with deficiencies of 9 credits or fewer in either program may be admitted as a degree candidate but will be required to make up such deficiencies without these credits being applicable toward the advanced degree. Admission is largely determined on the basis of achievement of a junior-senior grade-point average of 3.00 or better, above average scores on the GRE or GMAT, and appropriate prior course work. Students meeting these requirements can receive admission so long as space is available. Admission is normally for the fall semester.

## Degree Requirements

The core courses in mineral economics, economics, statistics, and other related fields are similar for all graduate students. At the M.S. level, the core courses constitute almost the entire program, and students without sufficient prior work find that they must earn 35 to 40 credits to meet these requirements. In addition to the normal degree requirements of the Graduate School, candidates for the M.S. degree must write a thesis or professional paper and defend it orally. Differences in prior training are most influential on the choice of thesis or professional paper topics. Those with an engineering or scientific background are more likely to undertake studies involving substantial technological elements while issues in the social sciences will be stressed by those with training in that area. M.S. students are required to take 9 to 12 credits in statistics and computer science either before admission or as courses taken in addition to the minimum required for the M.S. degree.

The Ph.D. program offers opportunities for students to extend work in either the technical or economic area. For those students who have a master's in a related area, their prior graduate work is considered to fulfill the requirement for work in related fields, and further work consists mainly of satisfying specific course requirements. Again, the backgrounds from prior work and what is done at Penn State will affect the orientation of the theses undertaken. Doctoral candidates must complete at least 15 credits in economics (including courses used for admission).

The candidacy examination for the doctorate is oral, and the oral examination for the M.S. degree at The Pennsylvania State University may be used as the candidacy examination for the doctorate. If this is done, the M.S. examination will be more detailed and broader in scope than it would be for the M.S. alone. The comprehensive examination for the doctorate includes written examinations in the major program and minor fields in addition to the oral examination required by the Graduate School. The communication requirement is satisfied by departmentally approved courses in mathematical statistics and mathematics. There is no foreign language requirement.

## Other Relevant Information

Students in this program may elect the dual-title degree program in Operations Research for the Ph.D. and M.S. degrees (see p. 285).

## Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

**ASARCO FOUNDATION FELLOWSHIP** — Available to a graduate student in mineral economics who is interested in writing his or her thesis on nonfuel mineral products, particularly those produced by the donor; grant of \$4,500 for tuition and expenses.

**RESOURCES FOR THE FUTURE/PENN STATE FELLOWSHIP** — Available to a graduate student in mineral economics doing work related to the RFF/Penn State mineral economics and public policy program in nonfuel minerals; stipend \$8,000.

## MINERAL ECONOMICS (MN EC)

453. NONMETALLIC MINERALS (3)

483. ECONOMICS OF THE METALS INDUSTRIES (3)

484. POLITICAL ECONOMY OF ENERGY AND THE ENVIRONMENT (3)

490. MINERAL VALUATION (3)

491. MINERAL INDUSTRIES DECISION MAKING (3)

504. ADVANCED PRINCIPLES OF MINERAL ECONOMICS (3) Minerals as capital — taxation, conservation, and land tenure; operations of mineral markets; government policy; minerals in world trade and development.

506. ADVANCED STUDIES IN MINERAL COMMODITIES (3) Economic studies of selected mineral commodities and their products.

509. (Geol. 509) GEOLOGY AND ECONOMICS OF THE CONSTRUCTION MATERIALS (3) Occurrence, origin, and marketing of the mineral materials used by the construction industry. Economic and geologic evaluation of actual deposits.

510. (Geol. 510) GEOLOGY AND ECONOMICS OF THE INDUSTRIAL MATERIALS (3) Occurrence, origin, and marketing of the industrial minerals and evaluation of deposits. Chemical and ceramic raw materials emphasized.



513. APPRAISAL OF MINERAL RESOURCES AND ANALYSIS OF EXPLORATION DECISIONS (3) Mineral resource concepts; various quantitative methods for resource evaluation, including computer simulation; exploration economics and decision making within quantitative frameworks. Prerequisite: Mn.Ec. 490.
519. MINERAL POLICY ANALYSIS (3) Principles of policy analysis; cost-benefit and other analytical techniques; environmental analyses; case studies of legislative and administrative mineral policy issues.
523. ECONOMIC ANALYSIS OF METAL INDUSTRIES (3) Economic analysis of metal supply, demand, markets, industry conduct and performance, trade, domestic and foreign policies. Prerequisite: Econ. 302.
524. THE ECONOMIC ANALYSIS OF ENERGY MARKETS (3) Unified theory of exploration, development, and production; its application; domestic and foreign public policies; new sources; forecasting. Prerequisite: Econ. 302.
529. MINERAL INVESTMENT VALUATION (3) Investment analysis for mineral properties, including reserve estimation, capital budgeting techniques under risk, taxation, capital cost, and selected investment decisions.
530. CONTEMPORARY ISSUES IN MINERAL FINANCE (3) Critical investigation of current problems in mineral finance, including the issues of capital availability, and domestic and foreign mineral investment. Prerequisite: Mn.Ec. 490 or Fin. 405.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## MINERAL ENGINEERING MANAGEMENT (M E M)

R. V. RAMANI, *Section Chairman of Mineral Engineering Management*  
104 Mineral Sciences Building  
814-863-1621

**Degree Conferred:** M.Eng.

### Senior Members of the Graduate Faculty

Frank F. Aplan, Sc.D. (M.I.T.) *Professor of Metallurgy and Mineral Processing*  
Robert L. Frantz, M.S. (Penn State) *Professor of Mining Engineering*  
Peter H. Given, D.Phil. (Oxford) *Professor of Fuel Science*  
Peter T. Luckie, Ph.D. (Penn State) *Professor of Mineral Processing*  
Lloyd A. Morley, Ph.D. (Utah) *Professor of Mining Engineering*  
Raja V. Ramani, Ph.D. (Penn State), P.E. *Professor of Mining Engineering*  
Matthew Rosenshine, Ph.D. (S.U.N.Y., Buffalo) *Professor of Industrial Engineering*  
Lee W. Saperstein, D.Phil. (Oxford) *Professor of Mining Engineering*  
George H. K. Schenck, Ph.D. (Penn State) *Associate Professor of Mineral Economics*  
C. Drew Stahl, Ph.D. (Penn State) *Professor of Petroleum and Natural Gas Engineering*

### Associate Members of the Graduate Faculty

Christopher J. Bise, Ph.D. (Penn State) *Assistant Professor of Mining Engineering*  
Turgay Ertekin, Ph.D. (Penn State) *Assistant Professor of Petroleum and Natural Gas Engineering*  
Richard D. Guild, Ph.D. (Northwestern) *Associate Professor of Industrial Engineering*  
Jan M. Mutmanský, Ph.D. (Penn State) *Associate Professor of Mineral Engineering*  
Lee B. Phelps, Ph.D. (Penn State) *Assistant Professor of Mining Engineering*

This program is designed to educate engineers for advancement into executive production management positions in the mineral and heavy construction industries, in development and sales in manufacturing companies, and in consulting firms. Its aim is to provide the knowledge, skills, and attitudes needed by persons to become innovators and responsible decision-making leaders. Participants are trained to create new designs, systems, and methods, and to plan, develop, and lead mineral industry organizations.

The content of appropriate courses is based upon specific problems encountered in the mineral industries. Such courses are offered by the departments which have combined their resources to offer

this interdisciplinary effort: the Departments of Mineral Engineering (Mining and Petroleum and Natural Gas sections), Mineral Economics, Materials Science and Engineering, and Industrial and Management Systems Engineering. Courses in these areas and others may be selected by students and adapted to their individual interests.

The program emphasizes quantitative methods, principles of economics applied in mineral industries, and management.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

For admission a bachelor's degree in one of six engineering branches of mineral industry (mining, petroleum, mineral processing, metallurgy, fuel, or ceramics) or some other closely related field (industrial, civil, geological, mechanical, or chemical engineering) is required. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

### Degree Requirements

Students are required to present a scholarly written report on a suitable project, the topic of which may be suggested by industry.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## MINERAL ENGINEERING MANAGEMENT (M E M)

510. PRODUCTION AND OPERATIONS MANAGEMENT (3-9) Overall planning, design, and selection of equipment; programming and scheduling of mineral operations; statistical control of costs and production indices.

## MINERAL PROCESSING (MN PR)

PETER T. LUCKIE, *In Charge of Graduate Programs in Mineral Processing*  
108 Steidle Building  
814-863-0373

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Frank F. Aplan, Sc.D. (M.I.T.) *Professor of Metallurgy and Mineral Processing*  
Leonard G. Austin, Ph.D. (Penn State) *Professor of Fuels and Mineral Engineering*  
Richard Hogg, Ph.D. (California, Berkeley) *Professor of Mineral Processing*  
K. Osseo-Asare, Ph.D. (California, Berkeley) *Associate Professor of Metallurgy*

### Associate Member of the Graduate Faculty

Peter T. Luckie, Ph.D. (Penn State) *Professor of Mineral Processing*

This program is one of the options in which a graduate student in the Department of Mineral Engineering can receive an advanced degree. After ores and minerals are mined, they are usually processed to concentrate valuable components or remove undesirable components; then they are converted into useful products. The world is facing shortages of energy, water, and raw materials, and the mineral processing engineering profession will play a key role in reducing and solving these problems. Increased efficiency and new ideas are urgently needed.

The training of a mineral processing engineer involves interdisciplinary combinations of chemis-



try, physics, the geological sciences, and engineering. This knowledge is then integrated with specialized knowledge — the creation, characterization, separation, agglomeration, and handling of mineral particles; the flotation and surface chemistry of mineral particles; and chemical extractions and separations — to provide the basis for developing and understanding the practical means of removal of valuable material from the rock body.

Pollution control is an important aspect of mineral processing because of the problems of disposal of large quantities of waste produced by the mineral industries, and the volume of process water used by the industries. The section cooperates in the all-University interdisciplinary program leading to the Master of Science in environmental pollution control or the Master of Environmental Pollution Control.

### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Graduates with bachelor's degrees in an engineering or science discipline are normally eligible for admission. Students with deficiencies may be required to take a modest amount of remedial work concurrently with their graduate studies. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds (such as industrial experience), abilities, and interests.

### **Master's Degree Requirements**

Students will be expected to demonstrate competence in areas outside of the major field and may be required to take courses in other fields. A research thesis is required of all M.S. students and must be defended orally before a committee of the faculty. Every student also will be expected to present a satisfactory seminar on the results of his or her research.

### **Doctoral Degree Requirements**

The communication and foreign language requirement for the Ph.D. degree may be satisfied by reading proficiency in one foreign language. Students whose first language is English must demonstrate proficiency in German, Russian, or Japanese (or other language in which a major body of relevant technical literature exists). Students whose first language is not English will be required to show fluency in reading, speaking, comprehending, and writing English and may in some cases be required to demonstrate proficiency in one other approved language.

No set number of credits is required, but a student normally would be expected to take a minimum of 15 credits of course work beyond the M.S. degree. Ph.D. candidates will be expected to demonstrate competence in the areas of (a) general mineral processing, (b) applied surface chemistry, (c) particle technology, (d) chemical processes, process metallurgy, and thermodynamics.

A minor field is not required. However, Ph.D. candidates will be expected to take at least 12 credits outside of the major. These courses need not be in a single field but should consist of a coherent group with some unifying theme.

Admission to candidacy is by examination (written and/or oral) and normally includes a satisfactory written paper consisting of a definition of the student's research problem and a critical evaluation of the relevant literature or a coherent critical review of the literature on some appropriate topic. In some cases, the Penn State M.S. thesis defense in mineral processing may be used to satisfy some or all of these requirements.

The comprehensive examination consists of two parts: (1) a written examination to test the candidate's factual knowledge of the general areas of mineral processing and his or her ability to synthesize this knowledge in the solution of problems; and (2) an oral examination by the doctoral committee including a presentation, by the candidate, of his or her research problem, relevant literature, data, and future plans. The committee will then examine the candidate concerning the research problem and background knowledge until they are satisfied they can make a decision.

### **Other Relevant Information**

A study panel of three faculty members, including the research adviser, is established for each student. The student and his or her research adviser prepare a proposed program of study, which is dis-

## MINERAL PROCESSING

cussed and approved at a meeting of the student and the study panel. The student and study panel meet at suitable intervals to review progress and modify the program if necessary.

### Student Aids

Graduate assistantships available through this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin. Graduate assistantships in Mineral Processing are generally for research and are usually available to qualified students.

## MINERAL PROCESSING (MN PR)

- 401. MINERAL PROCESS ENGINEERING (3)
- 410. INTRODUCTION TO QUANTITATIVE MINERAL PROCESSING ENGINEERING ANALYSIS (3)
- 413. MINERAL PROCESSING LABORATORY (1)
- 421. PARTICLE TECHNOLOGY LABORATORY (1-3)
- 424. COAL PREPARATION (3)
- 425. INTERFACIAL PHENOMENA AND FLOTATION (3)
- 426. (Metal. 426) HYDROMETALLURGY (3)
- 427. POLLUTION CONTROL IN THE MINERAL PROCESS INDUSTRIES (3)
- 451. SENIOR PROJECTS (1-6)

501. INTERFACIAL PHENOMENA IN MINERAL SYSTEMS (3) Applications of surface phenomena to mineral engineering systems. Thermodynamics of surfaces, flotation, adsorption of detergents, electrical double layer, flocculation, dispersion. Prerequisite: Chem. 451.

502. FROTH FLOTATION AND AGGLOMERATION (3) Intensive study of theory and applications of froth flotation and agglomeration. Prerequisite: Mn.Pr. 501.

505. PHYSICAL SEPARATIONS IN MINERAL PROCESSING (3) Intensive study of theory and applications of gravity, magnetic, electrostatic, centrifugal, and other methods of mineral processing. Prerequisite: Mn.Pr. 401.

506. MINERAL PROCESS PLANT DESIGN (3-10) Process design and economy. Development and quantification of flow sheets. Integration of unit operations. Plant layout, equipment selection, and instrumentation. Prerequisite: Mn.Pr. 401.

507. (Metal. 507) HYDROMETALLURGICAL PROCESSING (3) Fundamental physico-chemical factors underlying the aqueous extraction and recovery of metals and nonmetals from ores, minerals, and scrap metal. Prerequisite: Mn.Pr. (Metal.) 426.

508. MINERAL PARTICLE SYSTEMS (3) Creation, characterization, separation, and agglomeration of particles. Comminution, sizing, fractionation of powders; surface area, pore size determinations. Agglomeration and balling.

509. PARTICLE-FLUID DYNAMICS (3) Movement of particles in fluids, rheology of non-Newtonian mineral suspensions, design of concentrating devices, fluidized beds, electrodynamic, magnetic separations.

510. SIZE REDUCTION (3) Review of the state of the art in precise design of size reduction devices; their incorporation into mineral processing circuits.

520. MATHEMATICAL MODELING FOR MINERAL PROCESS ENGINEERS (3) Techniques for setting up mathematical models of physical processes of interest in mineral process engineering; analytical and computational methods of solution. Prerequisite: Math. 250.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)



## MINING ENGINEERING (MNG E)

LEE W. SAPERSTEIN, *Section Chairman of Mining Engineering*  
104 Mineral Sciences Building  
814-863-1619

**Degrees Conferred:** Ph.D., M.S., M.Eng.

### Senior Members of the Graduate Faculty

Z. T. Bieniawski, D.Sc. (Eng.) (Pretoria) *Professor of Mineral Engineering*  
Robert L. Frantz, M.S. (Penn State) *Professor of Mining Engineering*  
H. Reginald Hardy, Jr., Ph.D. (Virginia Polytechnic) *Professor of Mining Engineering*  
Lloyd A. Morley, Ph.D. (Utah) *Professor of Mining Engineering*  
Raja V. Ramani, Ph.D. (Penn State) *Professor of Mining Engineering*  
Lee W. Saperstein, D.Phil. (Oxford) *Professor of Mining Engineering*  
Barry Voight, Ph.D. (Columbia) *Professor of Geology*

### Associate Members of the Graduate Faculty

Christopher J. Bise, Ph.D. (Penn State) *Assistant Professor of Mining Engineering*  
Jan M. Mutmanský, Ph.D. (Penn State) *Associate Professor of Mining Engineering*  
L. Barry Phelps, Ph.D. (Penn State) *Assistant Professor of Mining Engineering*

Mining Engineering is one of the graduate programs within the Department of Mineral Engineering. The program objectives are to train students in the methodology of research and to expand the student's knowledge in selected subjects related to research as well as to the entire field of mining engineering.

Areas of specialization in research and course work include computer applications, environmental control, geomechanics and rock mechanics, health and safety, innovative mining systems, materials handling, mine electrical systems, mine maintenance, mine management, mine planning and reclamation, monitoring and control, operations research, surface mining, underground mining, and ventilation. Interests cover coal, metal, and nonmetal mining.

The program has outstanding facilities for mining engineering research. Among these are the C. B. Manula Computer Laboratory, the Mine Electrical Research Laboratory, the Rock Mechanics Laboratory, and the Ventilation Laboratory.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in the program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

A bachelor's degree in mining engineering or a related engineering field is required for admission at the master's level. Students may be required to make up deficiencies in basic related courses outside the department or in their area of specialization. Applicants with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds (such as industrial experience), abilities, and interests.

A master's degree in mining engineering or its equivalent is required for admission into the doctoral program. A copy of the student's master's thesis may be required as part of the application materials. A candidacy examination is required of all potential candidates.

### Master's Degree Requirements

A student who desires to obtain the M.S. degree is required to prepare a thesis. The thesis must be scholarly, reporting research of a contribution to the discipline, and it must be orally defended in front of an advisory committee of graduate faculty members.

A student who desires to obtain the M.Eng. degree is required to prepare a written report. The report must be a scholarly achievement, relating a developmental study that involves an appropriate, significant subject in the discipline.

## Doctoral Degree Requirements

The Ph.D. degree requires a minimum of 90 graduate credits, and up to 30 credits may be allowed for a previously obtained master's degree. A minimum of 60 course credits (400 and 500 series) and 30 research credits (Mng. 600) must be part of the program. At least 2 credits of Mng. 590 (Colloquium) also are needed during the period of candidacy.

Communications and foreign languages are required for the Ph.D. degree and may be satisfied by obtaining suitable credit either in two foreign languages or one foreign language plus advanced computer science studies. Foreign languages normally must be French, German, Russian, or Spanish, but in special circumstances, other languages may be accepted. Passing requirements are either a passing grade in ETS (Princeton) examinations or a minimum grade of B in associated 1G and 2G courses. Computer science studies are satisfied by obtaining a minimum grade of B in 6 credits of computer science above the undergraduate mining requirements. Courses taken to satisfy the communication and language requirements cannot be considered as part of the Ph.D. course requirements.

A comprehensive examination is required of all Ph.D. candidates and may be taken after substantial completion of course work and completion of the language requirements. The examination is the responsibility of the candidate's doctoral committee and takes the form of a written examination, which if successful, is followed by an oral examination as specified by the Graduate School.

A thesis is required of all Ph.D. candidates. It must be scholarly, reporting original research of significant contribution to the discipline. The ability to do independent research and competence in scholarly exposition must be demonstrated. The thesis must be defended in a final oral examination which is officially scheduled and announced by the Graduate School.

## Other Relevant Information

Students in this program may elect the dual-title degree program option in Operations Research for the Ph.D. and M.S. degrees (see p. 285).

## Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

**EXXON TEACHING FELLOWSHIP IN MINING ENGINEERING** — Available to an outstanding Ph.D. candidate in mining engineering who will be pursuing a college teaching career in the United States; stipend \$12,000-15,000 plus tuition.

**MINING AND MINERAL RESOURCES RESEARCH FELLOWSHIPS** — Available to graduate students majoring in mining and mineral sciences and pursuing M.S. and Ph.D. degrees; stipend \$6,240-7,100 for four semesters plus tuition.

**TEXACO FELLOWSHIP IN EARTH AND MINERAL SCIENCES** — Available to a graduate student in the College of Earth and Mineral Sciences; stipend \$1,200-3,000 plus tuition.

## MINING (MNG)

- 400. MINING AND OUR ENVIRONMENT (3)
- 402. MINE PLANT DESIGN (3)
- 403. MINE POWER SYSTEM DESIGN (3)
- 404. MINE MATERIALS HANDLING SYSTEMS (1)
- 405. MINE POWER SYSTEM MAINTENANCE AND HAZARD REDUCTION (3)
- 406. MINE MONITORING (3)
- 410. MINING ENGINEERING ANALYSIS (3)
- 411. MINE SYSTEMS ENGINEERING (3)
- 412. MINERAL PROPERTY EVALUATION (2)
- 422. MINE VENTILATION AND AIR CONDITIONING (3)
- 431. ROCK MECHANICS (3)
- 441. SURFACE MINING SYSTEMS AND DESIGN (3)
- 442. SURFACE MINE SEDIMENTATION CONTROL (2)
- 443. STRIP MINE CUT PLANNING (2)
- 451. ADVANCED MINING ENGINEERING (1-3)
- 460. MINE MAINTENANCE ENGINEERING (3)



502. MINE POWER SYSTEM PROTECTION (3) Protective circuitry, coordination, transient protection, and hazard reduction applied to mine power systems. Prerequisite: Mng. 403 or E.E. 425.
503. MINE POWER EQUIPMENT AND GROUNDING (3) Advanced analysis and design of mine power equipment, protective-relaying systems, and grounding systems. Prerequisites: Mng. 502, E.E. 425.
510. ADVANCED MINING SYSTEMS (3) Mining of thick, thin, or pitching seams; multiseam and in-situ mining; health and safety considerations. Prerequisite: Mng. 410.
513. MINE COST ANALYSIS (3) Nature of mining costs, their analysis and control: depreciation and depletion, capital and operating costs, budgets, records.
514. MINE OPERATIONS ANALYSIS (3) Application of operations research techniques in determining optimal design and operating policies for mine management. Prerequisite: Mng. 411.
515. MINE SYSTEMS SIMULATION (3) Principles and practices of probabilistic and deterministic simulation in the analysis of operating systems related to mills and mines. Prerequisites: Cmp.Sc. 201, Mng. 411.
516. MINING GEOSTATISTICS (3) Application of classical and spatial statistics in the study of mine exploration, ore reserve estimation, mining grade control, mine planning, and mine ventilation. Prerequisite: 3 credits of statistics at the 400 level.
531. RHEOLOGICAL AND STRENGTH CHARACTERISTICS OF ROCKS (3) Properties of rocks and their determination; failure theories; brittle to ductile transition; rheological behavior. Prerequisite: Mng. 431.
532. SPECIAL TOPICS IN ROCK MECHANICS (1-3) Behavior of rock under static loading; underground stress instrumentation; experimental stress analysis; design of mine openings; theories of subsidence.
541. SURFACE MINE EQUIPMENT SELECTION ANALYSIS (3) Design analysis and selection criteria for principal surface mine equipment, their interaction in operation, and auxiliary equipment requirements. Prerequisites: Mng. 441, C.E. 261.
542. THEORY OF ROCK FRAGMENTATION (3) Behavior of rock under dynamic loads intended to fragment; physical chemistry of explosives; detonation; theory of blasting; design of drill rounds. Prerequisites: E.Mch. 13, Mng. 30, Phys. 203.
543. STRATA CONTROL ENGINEERING (3) Theoretical considerations; convergence, abutments, subsidence; rockbursts; underground support systems; design of mine openings. Prerequisite: Mng. 431.
545. ROCK MECHANICS INSTRUMENTATION (3) Strain gauge circuitry, transducers, electrohydraulic servo installations, and integrated strain and force measuring systems as applied to rock mechanics. Prerequisite: Mng. 431.
551. THEORY OF ROCK FAILURE (3) Mechanism of rock failure, factors of influence, theories of failure, fracture toughness, fracture propagation, time dependency, implications in engineering practice. Prerequisite: Mng. 431.
552. GEOMECHANICS ASPECTS OF TUNNELING IN ROCK (3) Use of tunnels; site exploration; rock mass classification; tunnel design: analytical, observational, empirical; tunnel excavation and support; large, underground chambers. Prerequisite: Mng. 431 or C.E. 446.
553. ROCK SLOPE ENGINEERING (3) Mechanics of slope failure; geological data collection; shear strength of rock; groundwater flow; design of rock slopes, reinforcement, and monitoring. Prerequisite: Mng. 431.
554. ROCK MECHANICS DESIGN (3) Engineering design process; design of mines, tunnels, slopes, and underground chambers; guided design concept; creativity and innovation; group design project. Prerequisite: Mng. 543.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

## MOLECULAR AND CELL BIOLOGY (MCB)

R. A. DEERING, *In Charge of Graduate Programs in Molecular and Cell Biology*  
201 Althouse Laboratory  
814-865-0342

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Nathan N. Aronson, Jr., Ph.D. (Duke) *Associate Professor of Biochemistry*  
Reginald A. Deering, Ph.D. (Yale) *Professor of Molecular and Cell Biology*  
Alec D. Keith, Ph.D. (Oregon) *Adjunct Professor of Biophysics*  
Richard S. Morgan, M.D. (Columbia) *Associate Professor of Biophysics*  
Stanley R. Person, Ph.D. (Yale) *Professor of Biophysics and Molecular Biology*  
Robert A. Schlegel, Ph.D. (Harvard) *Associate Professor of Molecular and Cell Biology*  
Harald Schraer, Ph.D. (Cornell) *Professor of Cell Biology*  
Thomas Smyth, Jr., Ph.D. (Johns Hopkins) *Professor of Entomology and Biophysics*  
Wallace Snipes, Ph.D. (Duke) *Professor of Biophysics*  
S. Edward Stevens, Jr., Ph.D. (Texas) *Associate Professor of Microbiology*  
Greenville K. Strother, Ph.D. (Penn State) *Professor of Physics and Biophysics*  
William D. Taylor, Ph.D. (Manchester) *Professor of Biophysics*  
Paul W. Todd, Ph.D. (California) *Professor of Biophysics*

### Associate Members of the Graduate Faculty

Richard J. Frisque, Ph.D. (Wisconsin) *Assistant Professor of Microbiology*  
Ross C. Hardison, Ph.D. (Iowa) *Assistant Professor of Biochemistry*  
Kenneth A. Johnson, Ph.D. (Wisconsin) *Assistant Professor of Biochemistry*  
Ronald D. Porter, Ph.D. (Duke) *Assistant Professor of Microbiology and Molecular Genetics*  
David I. Shalloway, Ph.D. (M.I.T.) *Assistant Professor of Molecular Biology*  
Chen-Pei David Tu, Ph.D. (Cornell) *Assistant Professor of Biochemistry and Molecular Biology*

The major goal of this program is to train students for independent research and teaching in molecular and cell biology, and related fields. Students may enter the program from a variety of backgrounds such as biochemistry, biology, biophysics, cell biology, chemistry, genetics, microbiology, molecular biology, physics, premedicine, or others. The student's research starts during the first year. Research areas of faculty include biological membranes, calcification, cell fusion, chemical mutagenesis and carcinogenesis, DNA repair, flow cytofluorimetry, gene regulation, glycoprotein metabolism, electrophysiology, lysosome function, macromolecular assembly, molecular genetics, radiation biology, recombinant DNA, virology, and others.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Admission to the program is based on prior course record and grades, Graduate Record Examination, letters of recommendation, and interviews.

Virtually all students are admitted with the intent of obtaining a Ph.D. degree. Although the master's is usually obtained on the way to the Ph.D., this degree may be bypassed in some cases.

### Master's Degree Requirements

The M.S. degree has no requirements beyond those specified by the Graduate School. The master's program is expected to take about two years.

### Doctoral Degree Requirements

Advancement to Ph.D. candidacy is decided on the basis of course and research performance in addition to a written examination. A comprehensive oral examination and thesis defense are required later in the Ph.D. program. The Ph.D. takes about two to three years beyond the M.S.



**Other Relevant Information**

The course work and research are individually planned by the student and the adviser, in consultation with other faculty, to achieve consistency with the background, requirements, and interests of the student.

Research and instruction in aspects of molecular and cell biology also are conducted in several other graduate programs at University Park and at The Milton S. Hershey College of Medicine.

**Student Aids**

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

Under normal circumstances all students admitted to the program and continuing in good standing are provided with graduate assistantship support from University sources and research grants. For students obtaining fellowships, supplementation to the level of the assistantships also is provided.

**MOLECULAR AND CELL BIOLOGY (M C B)**

- 415. STRUCTURE OF BIOLOGICAL MACROMOLECULES (2)
- 430. MOLECULAR BIOLOGY OF THE GENE (3)
- 440. STRUCTURE AND FUNCTION OF BIOLOGICAL MEMBRANES (2)
- 450. (Micrb. 450) MICROBIAL/MOLECULAR GENETICS (2)
- 460. (Micrb. 460) ADVANCED CELL BIOLOGY (2)
- 474. PHYSICAL PROPERTIES OF BIOLOGICAL MACROMOLECULES (2)
- 475. MUTAGENESIS, CARCINOGENESIS, AND DNA REPAIR (2)
- 476. NEUROPHYSIOLOGY (3)
- 485. SENSORY SYSTEMS IN ANIMALS (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 504. (Biol. 504) SEMINAR IN CELL BIOLOGY (1) Discussion of current problems and ideas in cell biology with emphasis on reference to recent literature.
- 505. (Micrb. 505) MICROBIAL GENETICS (2 per semester, maximum of 4) Modern concepts in the genetics of microorganisms. Prerequisite: M.C.B. (Micrb.) 450.
- 514. (Bioch. 514) MOLECULAR BIOLOGY AND CELLULAR REGULATION (3) Structure, synthesis, and biochemical properties of nucleic acids; protein biosynthesis; control of gene expression; molecular genetics. Prerequisite: Bioch. 402.
- 560. MOLECULAR BASIS OF MUTAGENESIS AND CARCINOGENESIS (3) Action of physical and chemical environmental agents on genetic material; DNA repair; mutagenic and carcinogenic consequences. Prerequisite: M.C.B. 430.
- 589. MAMMALIAN CELL CULTURE (3) Recent research in quantitative cell biology as studied with tissues and cells of higher organisms cultured *in vitro*. Prerequisite: Bioch. 401.
- 590. COLLOQUIUM (1-3)
- 597. SPECIAL TOPICS (1-9)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

**MUSIC (MUSIC) and (MU ED)**

MAUREEN A. CARR, *Director, School of Music*  
 232 Music Building  
 814-865-0431

**Degrees Conferred:** D.Ed., M.A., M.Mus., M.Ed.

**Senior Members of the Graduate Faculty**

Robert W. Baisley, M.A. (Columbia) *Professor of Music*  
 Raymond H. Brown, B.S. (Johns Hopkins) *Professor of Music*  
 Maureen A. Carr, Ph.D. (Wisconsin) *Professor of Music*  
 Ned C. Deihl, D.Ed. (Penn State) *Professor of Music Education*

## MUSIC

Burt L. Fenner, M.A. (Columbia) *Professor of Music*  
Robert W. Holmes, Ph.D. (Boston) *Professor of Musicology*  
Bryce Jordan, Ph.D. (North Carolina) *Professor of Musicology*  
D. Douglas Miller, D.Mus. (Indiana) *Associate Professor of Music*  
Harry D. Perison, Ph.D. (Eastman) *Associate Professor of Music*  
Keith P. Thompson, Ph.D. (Case Western Reserve) *Associate Professor of Music Education*

### **Associate Members of the Graduate Faculty**

Joanne M. Feldman, M.S. (Juilliard) *Associate Professor of Music*  
Leonard Feldman, M.Mus. (Eastman) *Associate Professor of Music*  
Donald E. Hopkins, M.Mus. (Texas) *Associate Professor of Music*  
P. June Miller, M.Mus. (Yale) *Associate Professor of Music*  
Darhyl S. Ramsey, Ph.D. (Iowa) *Assistant Professor of Music Education*  
M. Suzanne Roy, D.M.A. (Wisconsin) *Assistant Professor of Music*  
Steven H. Smith, D.Mus.A. (Eastman) *Associate Professor of Music*  
Smith C. Toulson III, M.Mus. (Yale) *Associate Professor of Music*  
Robert Trehy *Professor of Music*  
W. Bruce Trinkley, M.A. (Columbia) *Associate Professor of Music*  
Dawn C. Wooderson, Ph.D. (Florida State) *Assistant Professor of Music Education*

### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in the program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Admission to the graduate program in Music requires the completion of a recognized baccalaureate degree in music or music education, with a junior-senior average of 2.80 or above, and is contingent upon departmental certification of the candidate's competence. Students who lack the recommended upper-class undergraduate courses may be required to take additional course work without receiving credit toward their degree.

### **Degree Requirements**

The Master of Arts degree (30 credits) is directed toward musicological research. A reading knowledge of either French or German is required, as is a thesis.

The Master of Education (30 credits) can include emphasis in various areas such as public-school music teaching, music supervision, college teaching, administration, or research. A master's paper is required.

The Master of Music (36 credits) provides three options for emphasis: performance, composition, and conducting. According to the area of specialization, an audition or the submission of manuscripts is required. Arrangements for this may be made by the student with the School of Music. Voice majors must demonstrate skill in foreign language diction. A recital and a master's paper are required for all M.Mus. candidates.

In all master's programs at least one-half of the required credits must be at the 500 level, and a comprehensive oral examination is required.

### **Doctoral Degree Requirements**

The Doctor of Education in Music Education (90 credits beyond the baccalaureate degree) is designed to prepare teachers and researchers for positions in institutions of higher education, as well as positions of leadership in large city systems and state departments of education. A candidacy examination is required, as are a doctoral thesis and comprehensive written and oral examinations.

### **Other Relevant Information**

The School of Music sponsors many musical ensembles, and candidates for degrees are required to participate in positions of responsibility. All candidates for degrees are expected to be in residence for a minimum of two semesters.

The School of Music is an associate member of the National Association of Schools of Music.

### **Student Aids**

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.



**MUSIC (MUSIC)**

Individualized instruction is offered in six categories covering twenty instruments:

Brass: Trumpet, French horn, trombone, euphonium, tuba  
 Keyboard: Piano, organ, harpsichord  
 Strings: Violin, viola, violoncello, doublebass, guitar  
 Woodwinds: Flute, oboe, clarinet, bassoon, saxophone  
 Percussion  
 Voice

For each instrument, individual instruction is offered to different types of students at different levels:

Performance instrument: Students in M.Mus.  
 Graduate levels I-IV  
 Secondary instrument: Students in M.A., M.S., M.Ed.  
 Graduate level I for 1 credit  
 Graduate level I for 2 credits

The courses are designated according to a particular pattern for identification on the student's transcript and in the *Schedule of Classes*. Applied music fees are required for individualized instruction: \$60 for a 1-credit course, \$100 for a 2-credit course, \$100 for a 4-credit course.

Example of listings:

Course Abbreviation	Number & Suffix	Instrument	Type of Student	Level	Credit	Fee
KEYBOARD	500 J	Piano	Secondary:	Level I	1	\$ 60
	510 J	Piano	Secondary:	Level II	2	100
KEYBOARD	530 J	Piano	Performance:	Level I	4	100
KEYBOARD	535 J	Piano	Performance:	Level II	4	100
KEYBOARD	570 J	Piano	Performance:	Level III	4	100
	575 J	Piano	Performance:	Level IV	4	100

403. CONCERT CHOIR (1 per semester, maximum of 4)
404. CHAMBER CHOIR (1 per semester, maximum of 4)
405. MUSICA DA CAMERA (1 per semester, maximum of 4)
406. COLLEGIUM MUSICUM (1 per semester, maximum of 4)
417. PERCUSSION PEDAGOGY (2)
418. VOCAL PEDAGOGY (3)
419. PIANO PEDAGOGY (3)
420. VOCAL ACCOMPANYING TECHNIQUES (2)
421. KEYBOARD MUSICIANSHIP (2)
422. JAZZ HARMONY AND ARRANGING (3)
431. ADVANCED ANALYSIS I (2)
432. ADVANCED ANALYSIS II (2)
440. MUSIC EXPERIENCES FOR THE PRESCHOOL CHILD (3)
442. ADVANCED GENERAL MUSIC METHODS (2)
443. ADVANCED CHORAL METHODS (2)
444. ADVANCED INSTRUMENTAL METHODS (2)
445. MUSIC FOR EXCEPTIONAL LEARNERS (3)
446. STUDENT TEACHING — ELEMENTARY GENERAL MUSIC (6-8)
447. STUDENT TEACHING — SECONDARY GENERAL MUSIC (6-8)
448. STUDENT TEACHING — SECONDARY CHORAL MUSIC (6-8)
449. STUDENT TEACHING — INSTRUMENTAL MUSIC (6-8)
450. TEACHING MARCHING BAND (3)
456. MULTIMEDIA COMPOSITION (3)
457. COMPOSITION (2 per semester, maximum of 16)
458. ELECTRONIC MUSIC (3)
461. MUSIC OF THE MIDDLE AGES AND EARLY RENAISSANCE (3)
462. MUSIC OF THE LATE RENAISSANCE AND THE BAROQUE ERA (3)
463. MUSIC OF THE CLASSICAL AND EARLY ROMANTIC PERIODS (3)
464. LATE ROMANTIC AND MODERN MUSIC (3)

## MUSIC

- 466. ADVANCED CONDUCTING (2)
- 467. OPERA WORKSHOP (1-6)
- 471. STRUCTURAL AND SIXTEENTH-CENTURY COUNTERPOINT (2)
- 472. EIGHTEENTH-CENTURY COUNTERPOINT (2)
- 481. KEYBOARD LITERATURE I (2)
- 482. KEYBOARD LITERATURE II (2)
- 483. PERCUSSION LITERATURE (3)
- 484. GUITAR LITERATURE (3)
- 485. CHAMBER MUSIC LITERATURE (2 per semester, maximum of 4)
- 486. WOODWIND LITERATURE (2 per semester, maximum of 4)
- 487. ORCHESTRAL LITERATURE (2 per semester, maximum of 4)
- 490. CHAMBER MUSIC FOR STRINGS (1 per semester, maximum of 4)
- 491. CHAMBER MUSIC FOR WOODWINDS (1 per semester, maximum of 4)
- 492. CHAMBER MUSIC FOR BRASS (1 per semester, maximum of 4)
- 493. SONATA DUOS (1 per semester, maximum of 4)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 500. INTRODUCTION TO MUSIC REFERENCE AND RESEARCH MATERIALS (2) A study of musicological reference and research materials in English and Western European languages, with exercises in their use.
- \*501. ADVANCED HARPSICHORD (3 per semester, maximum of 18) Instruction in harpsichord playing; preparation for recital performance. Fee \$100.
- \*503. ADVANCED ORCHESTRAL INSTRUMENTS (3 per semester, maximum of 18) Study, repertoire building, and recital performance. Fee \$80.
- \*504. INSTRUMENTAL AND VOCAL TECHNIQUES (1-2 per semester, maximum of 12) Weekly instruction in a performance area other than the student's major, emphasizing performance techniques and repertoire.
- \*511. ADVANCED PIANO (3 per semester, maximum of 18) Piano literature of all periods for public performance. Fee \$80.
- \*520. VOICE (3 per semester, maximum of 18) Study, repertoire building, and recital performance. Fee \$80.
- 531. ANALYTICAL TECHNIQUES (3) Intensive analytical study of selected compositions.
- \*535. FREE COMPOSITION (4) Composition for vocal, instrumental, and electronic media and preparation of compositions for performance.
- 540. INTRODUCTION TO GRADUATE STUDIES IN MUSIC EDUCATION (3) Bibliography; location and evaluation of reference materials; organization, form, and style in preparing music education research reports and other papers.
- 541. CONTEMPORARY MUSIC CURRICULA IN THE ELEMENTARY SCHOOL (3) Developing music curricula for the elementary school incorporating current theories, practices, materials, and research data.
- 542. CONTEMPORARY MUSIC CURRICULA IN MIDDLE AND JUNIOR HIGH SCHOOLS (3) Instructional materials, procedures, and curricular activities; integration with other subjects.
- 544. REVIEW AND CRITIQUE OF NEW BAND LITERATURE (3) Review and analysis of new band literature; emphasis is on concert band literature for all school levels.
- 545. PSYCHOLOGICAL FOUNDATIONS OF MUSICAL BEHAVIOR (3) Study of psychoacoustical effects of musical stimuli; emphasis on responses affecting learning musical ability, musical taste, and aesthetic reactions.
- 546. SELECTING AND DEVELOPING MEASURES OF MUSICAL BEHAVIOR (3) Constructing tests for musical measurement and examining existing standardized music measurement devices. Prerequisite: Music 545.

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\*Course may be scheduled only after consultation with the director of the School of Music.



547. **THE MATERIALS OF APPRECIATION (3)** Examination of written and recorded materials and appropriate techniques for developing appreciation of music at elementary, secondary, and college levels.
549. **INTERNSHIP IN MUSIC PERFORMANCE TECHNIQUES (1-6)** This course is designed to provide teaching experiences for the student while working under the supervision of School of Music faculty members.
550. **WIND AND PERCUSSION MATERIALS (3)** Survey of literature on the teaching of wind and percussion instruments, including solos, studies, and small ensembles. Prerequisite: Music 540.
551. **ADMINISTRATION AND SUPERVISION OF SCHOOL MUSIC (3)** Examination of procedures for effective supervision of music instruction and administration of school music programs. Prerequisite: five years of music teaching in public schools.
552. **INTERNSHIP IN MUSIC SUPERVISION (3-6)** Internship in schools under supervision of graduate faculty in music education. Prerequisites: Music 551, C.&S. 560.
554. **APPLIED ANALYSIS IN MUSIC LEARNING I (1)** Applied analysis of music teaching and learning in rehearsals, classrooms, and private studios.
555. **APPLIED ANALYSIS IN MUSIC LEARNING II (1)** Continuation of applied analysis of music teaching and learning in rehearsals, classrooms, and private studios. Prerequisite: Music 554.
556. **CHILDREN'S CHOIRS (1)** Performance class for teachers interested in developing choral programs for children (K-6). Participants will analyze, prepare, and present choral music. Prerequisite: keyboard and vocal experience.
557. **INTRODUCTION TO ORFF-SCHULWERK (1)** Introduction to Orff-Schulwerk music for children; designed to develop musicianship through an integration of speech, movement, and music.
558. **MASTER'S RESEARCH IN MUSIC EDUCATION (1-2)** Identification, investigation, and reporting of research related to a problem in the field of music education. Prerequisites: 20 graduate credits, including Music 540.
559. **CONTEMPORARY MUSIC EDUCATION (3)** This course examines contemporary trends in music education and places them within a framework of historical and philosophical significance. Prerequisites: 20 credits at the graduate level, including Music 540.
- \*560. **ORCHESTRAL AND CHORAL CONDUCTING (3 per semester, maximum of 18)** Supervised conducting in selected performance situations, rehearsal techniques, and comprehensive score analysis.
570. **MUSIC TO 1750 (3)** Studies of the development of musical styles from Gregorian chant through 1750, using reading, listening, and discussion.
572. **SEMINAR IN MUSICOLOGY (3 per semester, maximum of 9)** Research in selected areas of music history.
580. **STUDIES IN ORCHESTRAL LITERATURE (2)** Selected studies in orchestral literature from the seventeenth century to the present.
581. **STUDIES IN CHAMBER MUSIC LITERATURE (2)** Selected studies in chamber music of all types from the seventeenth century to the present.
582. **STUDIES IN KEYBOARD LITERATURE (2)** Studies in special topics of keyboard literature, using lecture, analysis, and performance. Prerequisites: Music 481, 482.
583. **STUDIES IN CHORAL LITERATURE (2)** Selected studies in choral literature of all types from the Renaissance to the present.
584. **STUDIES IN OPERATIC LITERATURE (2)** Studies in the development of the opera from 1600 to the present, treating both libretto and music.
585. **STUDIES IN VOCAL LITERATURE (2)** Selected studies in solo vocal literature of all periods.
589. **MUSIC SEMINAR (1-6)** Seminar in the history, art, and science of music, with readings, discussion, and performance.
594. **MASTER'S PAPER RESEARCH (1-6)** Investigation of a specific problem in music or music education.

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\*Course may be scheduled only after consultation with the director of the School of Music.

## NUCLEAR ENGINEERING

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

### MUSIC EDUCATION (MU ED)

501. PROBLEMS AND PROJECTS IN MUSIC EDUCATION (1-6) Independent work on special topics of music education pertinent to the development of curricula, methods, and materials in music education. Prerequisites: 12 graduate credits in education (including music education).

572. INSTRUMENTAL PEDAGOGY (1-6) Independent work on special problems in instrumental music pedagogy. Prerequisite: practical experience and 10 graduate credits in music and/or music education.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## NUCLEAR ENGINEERING (NUC E)

WARREN F. WITZIG, *Head of the Department*  
231 Sackett Building  
814-865-4911

**Degrees Conferred:** Ph.D., M.S., M.Eng.

### Senior Members of the Graduate Faculty

Ward S. Diethorn, Ph.D. (Carnegie Tech.) *Professor of Nuclear Engineering*  
Anthony H. Foderaro, Ph.D. (Pittsburgh) *Professor of Nuclear Engineering*  
William A. Jester, Ph.D. (Penn State) *Associate Professor of Nuclear Engineering*  
Edward S. Kenney, Ph.D. (Penn State) *Professor of Nuclear Engineering*  
Edward H. Klevans, Ph.D. (Michigan) *Professor of Nuclear Engineering*  
Samuel H. Levine, Ph.D. (Pittsburgh) *Professor of Nuclear Engineering*  
K. K. S. Pillay, Ph.D. (Penn State) *Adjunct Associate Professor of Nuclear Engineering*  
Forrest J. Remick, Ph.D. (Penn State) *Professor of Nuclear Engineering*  
Warren F. Witzig, Ph.D. (Pittsburgh) *Professor of Nuclear Engineering*

### Associate Members of the Graduate Faculty

Anthony J. Baratta, Ph.D. (Brown) *Assistant Professor of Nuclear Engineering*  
Gary L. Catchen, Ph.D. (Columbia) *Assistant Professor of Nuclear Engineering*  
George R. Imel, Ph.D. (Penn State) *Assistant Professor of Nuclear Engineering*  
Robert T. McGrath, Ph.D. (Michigan) *Assistant Professor of Nuclear Engineering*  
G. E. Robinson, Ph.D. (Penn State) *Associate Professor of Nuclear Engineering*

Programs of study are individually tailored, and engineering is emphasized through the study of reactor principles — computational methods, transport theory, and nuclear design; plasma principles — waves, analysis, and fusion laboratory; shielding — Monte Carlo and transport methods; reactor systems design — thermal, mechanical, and control; reactor fuels — configuration, radiation effects, and fuel cycle management; isotope utilization — activation analysis, chemical processes including nuclear medicine; safety analysis — reactor siting, engineered safeguards, environmental effects, probabilistic risk analysis, and digital handling and analysis of nuclear data.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are*



*in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. General aptitude GRE test results are required. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

### **Degree Requirements**

The department offers three degrees at the master's level: M.Eng., M.S. with paper, and M.S. with thesis. The communication requirement for the Ph.D. degree may be satisfied by proficiency in English.

### **Student Aids**

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

W. S. ELLIOTT FELLOWSHIP — Available to a graduate student who is a graduate of The Pennsylvania State University and is interested in engineering research; stipend variable. Apply to Office of the Dean, College of Engineering, 101 Hammond Building.

INSTITUTE OF NUCLEAR POWER OPERATIONS FELLOWSHIPS (3) — Available to graduate students in nuclear engineering; stipend \$5,500 plus tuition.

TAU BETA PI FELLOWSHIP — Open to any member of Tau Beta Pi, the engineering honor society, for a year of advanced study. Up to eighteen awards of \$3,500 each are available. Applications and information may be obtained from the Office of the Dean, College of Engineering, 101 Hammond Building. Application deadline is February 15.

U.S. DEPARTMENT OF ENERGY - ENERGY GRADUATE TRAINEESHIP PROGRAM — Available to graduate students working toward a Ph.D. degree in nuclear energy in areas related to nuclear technology; stipend \$8,100/year plus tuition.

U.S. DEPARTMENT OF ENERGY - NUCLEAR SCIENCE AND ENGINEERING AND HEALTH PHYSICS FELLOWSHIPS — Available to graduate students interested in engineering and engineering support related to nuclear technology and health physics; stipend \$1,000/month plus tuition.

U.S. DEPARTMENT OF ENERGY WASTE MANAGEMENT TRAINEESHIPS (8) — Available to graduate students interested in nuclear waste technology master's program; stipend \$6,240 plus tuition.

## **NUCLEAR ENGINEERING (NUC E)**

401. INTRODUCTION TO NUCLEAR ENGINEERING (3)

403. ADVANCED REACTOR DESIGN (3)

405. (Chem. 405) APPLIED NUCLEAR AND RADIOCHEMISTRY (3)

408. RADIATION SHIELDING (3)

415. RADIONUCLEAR APPLICATIONS (3)

420. RADIOLOGICAL SAFETY (3)

425. (Bioe. 425) RADIOGRAPHIC IMAGING (3)

428. RADIOACTIVE WASTE CONTROL (3)

430. DESIGN PRINCIPLES OF REACTOR SYSTEMS (3)

431. SYNTHESIS OF NUCLEAR SYSTEMS (3)

444. NUCLEAR REACTOR OPERATIONS LABORATORY (1)

445. NUCLEAR DIGITAL INSTRUMENTATION (3)

451. NUCLEAR ENGINEERING LABORATORY (4)

460. NUCLEAR SYSTEMS RISK ASSESSMENT (3)

490. (E.E. 490) INTRODUCTION TO PLASMAS (3)

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

501. REACTOR ENGINEERING (3) Reactor controls, shielding of nuclear reactors, stress analysis of reactor materials, power cycle analysis, breeding, and advanced design considerations. Prerequisites: Nuc.E. 302; Nuc.E. 430 or M.E. 412.

## NURSING

502. REACTOR ENGINEERING LABORATORY (1-5) Reactor experiments devised to acquaint the student with reactor technology. Prerequisite or concurrent: Nuc.E. 302 (only if more than 1 credit of Nuc.E. 502 is taken).
503. THERMONUCLEAR ENGINEERING (3) Binary fusion reactions; microscopic and macroscopic phenomena in a completely ionized gas; electromagnetic confinement; design, operation, and diagnostics of experiments. Prerequisite: Nuc.E. 490.
505. REACTOR INSTRUMENTATION AND CONTROL (3) Neutron-detecting instruments and circuits; in-core power instrumentation; reactor control principles; control mechanisms; operational control problems. Prerequisite: Nuc.E. 302.
512. NUCLEAR FUEL MANAGEMENT (3) Nuclear fuel inventory determination and economic value through the fuel cycle. Emphasis on calculational techniques in reactor, optimization, and design. Prerequisite: Nuc.E. 302.
520. REACTOR ANALYSIS (3) Physical principles and mathematical methods of reactor analysis. Prerequisite: Nuc.E. 403.
521. NEUTRON TRANSPORT THEORY (3) Derivation of Boltzmann equation for neutron transport; techniques of approximate and exact solution for the monoenergetic and spectrum regenerating cases. Prerequisite: Nuc.E. 403 or Phys. 406.
540. (E.E. 540) THEORY OF PLASMA WAVES (3) Solutions of the Boltzmann equation; waves in bounded and unbounded plasmas; radiation and scattering from plasmas. Prerequisite: Nuc.E. (E.E.) 490.
541. (E.E. 541) PLASMA THEORY (3) Advanced topics in kinetic theory, fluctuation theory, microinstability, and turbulence. Prerequisite: Nuc.E. (E.E.) 490.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## NURSING (NURS)

LAURIE M. GUNTER, *In Charge of the Graduate Program in Nursing*  
203 East Henderson Human Development Building  
814-863-0245

**Degree Conferred:** M.S.

### Senior Members of the Graduate Faculty

Annette Ezell, Ed.D. (Brigham Young) *Professor of Nursing*  
Laurie M. Gunter, Ph.D. (Chicago) *Professor of Nursing and Human Development*  
Margaret Newman, Ph.D. (N.Y.U.) *Professor of Nursing*  
John S. Packard, Ph.D. (Penn State) *Professor of Nursing*  
Elizabeth J. Susman, Ph.D. (Penn State) *Assistant Professor of Nursing*

### Associate Members of the Graduate Faculty

Jorge Grimes, Ed.D. (S.U.N.Y., Buffalo) *Associate Professor of Nursing*  
Jessie F. Igou, Dr.P.H. (Johns Hopkins) *Assistant Professor of Nursing*  
Grace Laubach, M.A. (Columbia) *Associate Professor of Nursing*  
Margaret P. Mandrillo, Ed.D. (Columbia) *Associate Professor of Nursing*  
Joan M. Rinehart, Ph.D. (Maryland) *Associate Professor of Nursing*  
Lois H. Snader, D.Ed. (Penn State) *Assistant Professor of Nursing*  
Alice Ida Tetreault, Ed.D. (North Carolina State) *Associate Professor of Nursing*  
Janet A. Williamson, R.N., Ph.D. (Penn State) *Associate Professor of Nursing*  
Elaine W. Young, Ph.D. (Penn State) *Assistant Professor of Nursing*  
Lucy C. Yu, Ph.D. (Michigan) *Associate Professor of Nursing*

The Master of Science degree is offered in recognition of the completion of a program which emphasizes productive scholarship and research in preparation of the advanced nursing specialist. The pro-



gram is accredited by the National League for Nursing (NLN). A minor in Nursing is offered at the doctoral level.

The Nursing Consultation Center, located on the first floor of the Nursing Building, has a nursing practice facility which provides a setting for students and faculty to test and implement a nursing practice model consistent with the philosophy and objectives of the Nursing program. It provides examination rooms, small and large conference rooms, room with two-way viewing and television recording facilities, and rooms specially furnished for group work with children, youths, adults, and the elderly. It is arranged to provide for nursing practice and research in the care of individuals, families, and groups.

#### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Applicants should hold a baccalaureate degree in nursing from an NLN-accredited program and must submit the official results of the verbal and quantitative tests of the Graduate Record Examination. An overall grade-point average of 3.00 is expected for undergraduate work. Courses in basic statistics and introduction to research are required. Applicants who do not meet the established criteria may be considered on an individual basis.

#### **Degree Requirements**

Each student must earn a minimum of 40 graduate credits, with at least 30 earned as approved resident credits. A core of courses in nursing theory, research, and models of practice is required of all students. Students may select an area of specialization in nursing from among young and middle-aged adult health, older adult health, family health, and community health. Functional preparation is required in teaching, administration, or practice. In addition, 10 credits are required for statistics and thesis work. Each student must complete a thesis.

#### **Student Aids**

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

U.S. PUBLIC HEALTH SERVICE TRAINEESHIPS IN NURSING — Open to selected registered nurse students in nursing; stipend may be available plus tuition. Apply to Professor in Charge, Graduate Program in Nursing.

VETERANS ADMINISTRATION HEALTH PROFESSIONAL SCHOLARSHIP PROGRAM — To assist in providing an adequate supply of professional nurses for the Veterans Administration and the nation. Open to nursing students in baccalaureate and clinical master's programs; provides tuition/fees, reasonable educational expenses, and a monthly stipend.

#### **NURSING (NURS)**

- 401. CONCEPTS OF HEALTH (3)
- 402. HOLISTIC HEALTH (3)
- 405. OCCUPATIONAL HEALTH NURSING (3)
- 410. NURSING CARE OF THE FAMILY IN THE COMMUNITY (3)
- 425. SCHOOL HEALTH NURSING (3)
- 445. TRAUMA NURSING (3)
- 450. REHABILITATION NURSING (3)
- 455. NURSING RELATED TO COMPLEX HEALTH PATTERNS I (3)
- 460. NURSING RELATED TO COMPLEX HEALTH PATTERNS II (3)
- 464. DYING AND DEATH (3)
- 486. NURSING LEADERSHIP (2)
- 495. NURSING STUDY IN SPECIALIZED SETTING (1-12)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

## NUTRITION

501. ISSUES IN NURSING AND HEALTH CARE (2) Consideration of personal, social, political, economic, philosophical, ethical problems/questions and ways of confronting and resolving conflicts in professional practice.

510. THEORETICAL FOUNDATIONS OF NURSING (3) Examines current conceptual models in nursing and relationship of empirical data and existing theories to the development of nursing science.

511. DESIGN AND ANALYSIS OF CLINICAL STUDIES IN NURSING (3) Analysis and critical evaluation of nursing research with emphasis on designs appropriate to nursing phenomena. Prerequisite: Ed.Psy. 406 or Soc. 470 or an intermediate statistics course.

512. MODELS OF NURSING PRACTICE (3) Integration and application of current nursing theory and research to the development of a model of nursing practice. Prerequisites: Nurs. 510, 511.

514. NURSING STRATEGIES FOR CHILD AND ADOLESCENT HEALTH (3) Development of a conceptual framework for nursing practice with children/adolescents through analysis and synthesis of selected theories and research. Prerequisite: Nurs. 512.

516. NURSING STRATEGIES FOR ADULT HEALTH (3) Development of a conceptual framework for nursing practice with adults through analysis and synthesis of selected theories and research. Prerequisite: Nurs. 512.

524. NURSING STRATEGIES FOR OLDER ADULT HEALTH (3) Development of a conceptual framework for nursing practice with older adults through analysis and synthesis of selected theories and research. Prerequisite: Nurs. 512.

526. NURSING STRATEGIES FOR FAMILY HEALTH (3) Development of a conceptual framework for nursing practice with communities through analysis and synthesis of selected theories and research. Prerequisite: Nurs. 512.

528. NURSING STRATEGIES FOR COMMUNITY HEALTH (3) Synthesis of selected community-level theories describing man-environment interaction and related health factors within models of nursing practice. Prerequisite: Nurs. 512.

530. CLINICAL PROCESS IN NURSING PRACTICE (1-10) Application of a model of nursing practice to a selected client population. Prerequisite: completion of advanced nursing theory courses in selected clinical areas.

550. TRANSCULTURAL HEALTH NURSING (3) Theoretical background for design, implementation, evaluation of nursing care to promote, maintain, and restore health, congruent with cultural patterns.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## NUTRITION (NUTR)

HELEN A. GUTHRIE, *In Charge of Graduate Programs in Nutrition*  
106 Henderson Human Development Building  
814-863-0772

**Degrees Conferred:** Ph.D., M.S., M.Ed.; M.S. in Nutrition in Public Health

### Senior Members of the Graduate Faculty

Elsworth Buskirk, Ph.D. (Minnesota) *Professor of Applied Physiology*

Gary J. Fosmire, Ph.D. (California) *Assistant Professor of Nutrition Science*

Michael H. Green, Ph.D. (California) *Assistant Professor of Nutrition Science*

Helen A. Guthrie, Ph.D. (Hawaii) *Professor of Nutrition*

Penny M. Kris-Etherton, Ph.D. (Minnesota) *Assistant Professor of Nutrition*

Thomas F. Massaro, Ph.D. (Cornell) *Assistant Professor of Nutrition*

Gerald E. McClearn, Ph.D. (Wisconsin) *Professor of Nutrition*

Barbara M. Shannon, Ph.D. (Purdue) *Associate Professor of Nutrition*

Laura S. Sims, Ph.D. (Michigan State) *Associate Professor of Nutrition in Public Health*

John Edgar Smith, Ph.D. (Nebraska) *Associate Professor of Nutrition*

Helen S. Wright, Ph.D. (Penn State) *Associate Professor of Nutrition*



**Associate Members of the Graduate Faculty**

Dorothy Blair, Ph.D. (Cornell) *Assistant Professor of Nutrition*

Carol Byrd-Bredbenner, Ph.D. (Penn State) *Assistant Professor of Nutrition*

The graduate programs in Nutrition emphasize both basic nutrition research and the application of knowledge of nutrition science and human behavior to the improvement of the nutritional status of individuals and communities. Graduates are prepared for careers in college teaching, community nutrition and public-health nutrition, nutrition education, clinical nutrition, and basic and applied research in nutrition. The course of study is planned to meet the professional objectives of the individual student.

Research focuses on issues with special application to human nutrition. Current research emphasizes trace elements, vitamin A, lipid metabolism, nutrition and behavior, nutrition education strategies, and evaluation of nutritional status and nutrition policy.

Facilities in human nutrition include four well-equipped nutrition science laboratories with animal facilities supervised by a University laboratory animal resource staff. The Nutrition Information and Resource Center and the program in nutrition education serve as a laboratory for students in community nutrition and nutrition education, and the Nutrition Clinic serves this function for those in clinical nutrition.

**Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

A junior-senior grade-point average of 3.00 is required except in extenuating circumstances when students with a grade-point average of 2.80 may be accepted. GRE scores of 1050 or higher (verbal plus quantitative) are competitive. Analytical scores above 500 are desirable.

Minimum course requirements include 3 credits each of inorganic or organic chemistry, microbiology, biochemistry, and human physiology, and 8 credits of nutrition courses. Candidates for a degree in nutrition in public health must also have 6 credits of social science and preferably the academic requirements for membership in the American Dietetic Association. Deficiencies must be completed with a grade of B or better within the first year.

A limited number of outstanding students may be admitted directly into the doctoral program, but most applicants are encouraged to enter and complete a master's degree. Candidates for the doctoral degree are admitted provisionally pending successful completion of the doctoral candidacy examination.

**Master's Degree Requirements**

The graduate program in Nutrition offers M.S. degrees in the area of nutrition science and the M.Ed. and M.S. degrees in the area of applied nutrition. The applied nutrition option includes programs in community nutrition, nutrition in public health, nutrition education, and clinical nutrition.

The M.S. degree requires 30 credits of course work, including 6 credits of original research (Nutr. 600). The M.S. degree in the area of nutrition education requires 36 credits, including 12 credits in education and teaching experience (Nutr. 602, no credit). The M.S. degree in nutrition in public health requires 45 credits, including a 4-credit field experience (Nutr. 555).

The M.Ed. degree requires 30 credits, including 6 credits in education and a 3-credit paper (Nutr. 530).

**Doctoral Degree Requirements**

The Ph.D. degree is offered in the areas of nutrition science and applied nutrition. Doctoral students must demonstrate competency in spoken English as judged by the program faculty and in technical writing by completion of Engl. 418 with a grade of B or better. There are no specific course requirements. The academic program is developed by the student in consultation with his or her adviser to develop doctoral level competence in nutrition and one or more supporting areas.

Students are expected to participate in Colloquium (Nutr. 590) each semester and enroll in Seminar (Nutr. 551) on a regular basis.

## NUTRITION

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

GENERAL FOODS FELLOWSHIP FOR DOCTORAL CANDIDATES IN NUTRITION EDUCATION — \$5,000 per year.

KRAFT FELLOWSHIPS IN NUTRITION EDUCATION — Three \$3,000 or two \$4,500 awards per year to master's or doctoral students.

### NUTRITION (NUTR)

- 400. INTRODUCTION TO NUTRITION COUNSELING (1-3)
- 420. EXPERIMENTAL FOODS (4)
- 421. CULTURAL ASPECTS OF FOODS (3)
- 422. ADVANCED FOODS (3)
- 452. NUTRITIONAL ASPECTS OF DISEASE (3)
- 453. DIET THERAPY (2)
- 454. LABORATORY METHODS IN NUTRITION (3)
- 456. COMMUNITY NUTRITION (2)
- 457. PRINCIPLES OF HUMAN NUTRITION (3)
- 458. DEVELOPMENTAL NUTRITION (2)
- 459. ADVANCED NUTRITION (3)
- 490. FOODS AND NUTRITION SEMINAR (1)
- 495. ADVANCED FIELD EXPERIENCE IN NUTRITION (1-6)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 522. ADVANCED EXPERIMENTAL FOODS (3) Experimental methods used in measuring the quality of foods; specific problems in food preparation.
- 530. PROBLEMS IN FOODS AND NUTRITION (1-6)
- 550. READINGS IN NUTRITION (3) Readings and reports of selected topics in nutrition.
- 551. SEMINAR IN NUTRITION (1-6) Selected topics and recent advances in nutrition.
- 552. NUTRITION IN DISEASE (2) Physiological and biochemical problems in metabolic diseases and the nutritional aspects of therapy.
- 555. FIELD WORK IN NUTRITION (2-4) Field problems planned to meet the needs of individual students. Hours and problems to be arranged.
- 556. THE SURVEY METHOD IN FOODS AND NUTRITION (2) Study of survey techniques as a tool in the assay of food adequacy and nutritional status.
- 557. INTERRELATIONSHIPS OF NUTRIENTS (2) Interrelationships of nutrients in the metabolic processes; their significance as applied to nutrition.
- 558. PROTEIN NUTRITION (2) Classical concepts, recent developments, and applied aspects of protein and amino acid nutrition and metabolism. Prerequisite: graduate standing in nutrition or related field.
- 560. PUBLIC HEALTH NUTRITION (3) Overview of public health nutrition field and profession: administration of public health nutrition programs, including program planning, implementation, and evaluation. Prerequisites: Nutr. 453, 456.
- 561. PUBLIC HEALTH NUTRITION: PROGRAMS/SERVICES (2) Organization of the nutrition component of programs administered by health agencies; application of knowledge and skills to effect planned change. Prerequisite: Nutr. 560.
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)



## OPERATIONS RESEARCH (O R)

A. V. WILLIAMS, *Chairman of the Committee on Operations Research*  
324 Walker Building  
814-865-2493

**Degrees Conferred:** Students electing this option through participating programs will earn a degree with a dual title at both the Ph.D. and the M.S. or M.A. levels, i.e., Ph.D. in (graduate program name) and Operations Research, or M.S. or M.A. in (graduate program name) and Operations Research.

### Senior Members of the Graduate Faculty

Sumer C. Aggarwal, Ph.D. (Moscow University, USSR) *Professor of Management Science*  
Charles E. Antle, Ph.D. (Oklahoma State) *Professor of Statistics*  
Leonard G. Austin, Ph.D. (Penn State) *Professor of Fuels and Mineral Engineering*  
Virgil E. Crowley, Ph.D. (Missouri) *Professor of Farm Management Extension*  
Samuel G. Davis, Ph.D. (Syracuse) *Assistant Professor of Management Science*  
John D. Daniels, Ph.D. (Michigan) *Professor of Business Administration*  
Ernest E. Enscoe, Jr., Ph.D. (Penn State) *Associate Professor of Industrial Engineering*  
Rodney A. Erickson, Ph.D. (Washington) *Associate Professor of Geography*  
Richard L. Gordon, Ph.D. (M.I.T.) *Professor of Mineral Economics*  
Peter R. Gould, Ph.D. (Northwestern) *Professor of Geography*  
Richard D. Guild, Ph.D. (Northwestern) *Associate Professor of Industrial Engineering*  
Frank A. Haight, Ph.D. (New Zealand) *Professor of Statistics and Transportation*  
Milton C. Hallberg, Ph.D. (Iowa State) *Professor of Agricultural Economics*  
William L. Harkness, Ph.D. (Michigan State) *Professor of Mathematical Statistics*  
Jack C. Hayya, Ph.D. (U.C.L.A.) *Professor of Management Science*  
George Heitmann, Ph.D. (Princeton) *Professor of Management Science*  
Michael P. Hottenstein, D.B.A. (Indiana) *Professor of Management*  
Teh-Wei Hu, Ph.D. (Wisconsin) *Professor of Economics*  
James P. Ignizio, Ph.D. (Virginia Polytechnic) *Associate Professor of Industrial Engineering*  
Donald B. Johnson, Ph.D. (Cornell) *Associate Professor of Computer Science*  
David F. Kibler, Ph.D. (Colorado State) *Professor of Civil Engineering*  
George B. Kleindorfer, Ph.D. (Carnegie-Mellon) *Associate Professor of Management Science and Organizational Behavior*  
C. Gregory Knight, Ph.D. (Minnesota) *Professor of Geography*  
Gary A. Kochenberger, D.B.A. (Colorado) *Professor of Management Science*  
Allan M. Krall, Ph.D. (Virginia) *Professor of Mathematics*  
John B. Lewis, Ph.D. (Purdue) *Professor of Electrical Engineering*  
Patrick D. Lynch, Ph.D. (Minnesota) *Professor of Education*  
Stuart H. Mann, Ph.D. (Case Western Reserve) *Professor of Operations Research*  
George J. McMurtry, Ph.D. (Purdue) *Professor of Electrical Engineering*  
Yash P. Mehra, Ph.D. (Minnesota) *Associate Professor of Economics*  
Wayne L. Myers, Ph.D. (Michigan) *Associate Professor of Forest Biometrics*  
Jon P. Nelson, Ph.D. (Wisconsin) *Professor of Economics*  
J. Keith Ord, Ph.D. (London) *Professor of Management Science*  
Torrence D. Parsons, Ph.D. (Princeton) *Professor of Mathematics*  
Earl J. Partenheimer, Ph.D. (Michigan State) *Professor of Agricultural Economics*  
Claude D. Pegden, Ph.D. (Purdue) *Associate Professor of Industrial Engineering*  
Raja V. Ramani, Ph.D. (Penn State), P.E. *Professor of Mining Engineering*  
David L. Raphael, M.A. (Michigan) *Professor of Industrial Engineering*  
Edward T. Reutzel, Ph.D. (Penn State) *Associate Professor of Management Science*  
Paul H. Rigby, Ph.D. (Texas) *Professor of Business Administration*  
Matthew Rosenshine, Ph.D. (S.U.N.Y.) *Professor of Industrial Engineering*  
Thomas A. Ryan, Jr., Ph.D. (Cornell) *Associate Professor of Statistics*  
Ned Shilling, Ph.D. (Columbia) *Professor of Quantitative Business Analysis*  
Allen L. Soyster, Ph.D. (Carnegie-Mellon) *Professor of Industrial and Management Systems Engineering*  
H. Randolph Thomas, Jr., Ph.D. (Vanderbilt) *Associate Professor of Civil Engineering*  
John E. Tilton, Ph.D. (Yale) *Professor of Mineral Economics*  
Brian J. Turner, D.For. (Yale) *Associate Professor of Forest Management*  
Robert D. Weaver, Ph.D. (Wisconsin) *Assistant Professor of Agricultural Economics*  
Jack H. Willenbrock, Ph.D. (Penn State), P.E. *Associate Professor of Civil Engineering*  
Anthony V. Williams, Ph.D. (Michigan State) *Associate Professor of Geography*  
Donald J. Willower, Ed.D. (Buffalo) *Professor of Education*

### Associate Members of the Graduate Faculty

James G. Beierlein, Ph.D. (Purdue) *Assistant Professor of Agricultural Economics*  
M. Jeya Chandra, Ph.D. (Syracuse) *Assistant Professor of Industrial Engineering*

Goong Chen, Ph.D. (Wisconsin) Associate Professor of Mathematics  
James W. Dunn, Ph.D. (Oklahoma State) Assistant Professor of Agricultural Economics  
Greg N. Frederickson, Ph.D. (Maryland) Assistant Professor of Computer Science  
William W. Hager, Ph.D. (M.I.T.) Associate Professor of Mathematics  
R. H. Jacoby, M.S.E. (Michigan) Associate Professor of Petroleum and Natural Gas Engineering  
Joseph Lambert, Ph.D. (Purdue) Associate Professor of Computer Science and Mathematics  
Samuel H. Levine, Ph.D. (Pittsburgh) Professor of Nuclear Engineering  
Victor Levine, Ph.D. (Columbia) Assistant Professor of Education  
Peter T. Luckie, Ph.D. (Penn State) Professor of Mineral Processing  
James D. Lynch, Ph.D. (Florida State) Assistant Professor of Statistics  
Deborah J. Medeiros, Ph.D. (Purdue) Assistant Professor of Industrial Engineering  
Bruce Michie, Ph.D. (Wisconsin, Madison) Assistant Professor of Forest Resources  
Wendell H. Mills, Jr., Ph.D. (Michigan) Assistant Professor of Mathematics  
Jan M. Mutmanský, Ph.D. (Penn State) Associate Professor of Mineral Engineering  
William Burdette Roush, Ph.D. (Oregon State) Assistant Professor of Poultry Science  
Robin A. J. Taylor, Ph.D. (Imperial, London) Assistant Professor of Entomology  
Richard E. Zindler, Ph.D. (Michigan State) Professor of Engineering Research

The Operations Research dual-title degree program option is administered by an Operations Research Committee, which is responsible for management of the program. The committee maintains program definition, identifies faculty and courses appropriate to the option, and recommends policy and procedures for its operation to the dean of the Graduate School. This dual-title degree program is offered as an option through graduate major programs in eight colleges. The option enables students from diverse graduate programs to attain and be identified with the tools, techniques, and methodology of operations research, while maintaining a close association with areas of application. Operations research is the analysis — usually involving mathematical treatment — of a process, problem, or operation to determine its purpose and effectiveness and to gain maximum efficiency. To pursue a dual-title degree under this program option the student must apply to the Graduate School and register through one of the following graduate major programs: Agricultural Economics, Business Administration, Civil Engineering, Computer Science, Economics, Educational Administration, Electrical Engineering, Entomology, Forest Resources, Geochemistry and Mineralogy, Geography, Industrial Engineering, Man-Environment Relations, Mathematics, Mineral Economics, Mining Engineering, Petroleum and Natural Gas Engineering, Poultry Science, or Statistics.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

There are no prerequisites for admission to the M.S. or M.A. program option other than those that may be imposed by the participating graduate major programs.

For the Ph.D. degree with Operations Research option, in addition to those prescribed by the graduate major program, prerequisites for acceptance to the program without deficiency include the following or their equivalent: Math. 140, 141, 231, 251, and 220; Cmp.Sc. 101; and 6 credits in elementary or introductory micro- or macroeconomics.

### Degree Requirements

To qualify for a dual-title degree, students must satisfy the requirements of the graduate major programs in which they are enrolled, in addition to the minimum requirements, or their equivalent, in the Operations Research option. Students must enroll in O.R. 590, Colloquium, for at least 1 credit in each year enrolled in the program and in residence.

For the M.S. or M.A. degree with Operations Research option, 18 credits are required from the areas of statistical methods, computer science, optimization (survey-level courses acceptable), processes (survey-level courses acceptable), and applications. (Application courses are those that involve problem solving through the use of decision methods.) At least 3 credits must be selected from each area. Particular courses may satisfy both the graduate major program requirements and those in the Operations Research option. A thesis may be required, the supervisor of which must be a member of the Graduate Faculty recommended by the chairman of the program granting the degree and approved by the Operations Research Committee as qualified to supervise thesis work in operations re-



search. A paper or report may be written in lieu of the M.S. or M.A. thesis upon approval of the student's graduate major program. A student selecting the paper or report must take an additional 6 credits in the Operations Research program. It is the prerogative of the graduate major program to assign these credits to one or more of the following categories: statistical methods, computer science, optimization, processes, and applications.

The minimum requirements for the Ph.D. degree with Operations Research option are (1) Mathematics — 9 credits minimum including real analysis (Math. 401) and linear algebra (Math. 441); (2) Statistics — 9 credits minimum with a 6-credit sequence in mathematical statistics (Stat. 409, 410) or in experimental statistics (Stat. 401) and 3 credits in stochastic processes (Stat. 416); (3) Optimization — 12 credits minimum including linear programming I and II, mathematical programming I, and dynamic programming; (4) Processes — 9 credits minimum including inventory models, scheduling models, and waiting line models; (5) Computer Science — 6 credits minimum including numerical methods and digital simulation techniques; and (6) Open Areas (application and/or specialization) — 15 credits minimum.

A Ph.D. minor program in Operations Research is available for doctoral students in graduate programs who find it advantageous to include advanced quantitative methods of systems analysis in their program of study and have been approved to do so by their doctoral committee. To qualify for a minor in Operations Research, students must satisfy the requirements of their graduate major program and take at least 15 credits from the following areas: statistical methods or mathematical statistics, computer science, optimization, and processes. At least 3 credits must be taken from each of optimization and processes areas as listed below.

The doctoral committee is recommended by the graduate major program granting the degree. The chairman and at least two members of a doctoral committee must be members of the Graduate Faculty and approved by the Operations Research Committee as qualified to supervise doctoral theses in operations research. The Operations Research Committee is responsible for administering an examination in operations research which constitutes a portion of the comprehensive examination administered to the doctoral student in the program option, as well as to the candidate who chooses operations research as a minor field.

Courses of a like nature identified as the core of the program option have been given generic names and descriptions. Each such listing may be satisfied by one of the courses given under it.

## OPTIMIZATION AREA

*Linear Programming I* An introduction to the theory and methodology of linear programming.

I.E. 405

Q.B.A. 451

*Linear Programming II* A further treatment of the theory and methodology of linear programming with emphasis on special formulations.

I.E. 510

*Mathematical Programming I* Introduction to optimization theory designed to provide the necessary fundamentals for nonlinear programming and more advanced studies in mathematical programming.

Q.B.A. 452

*Mathematical Programming II* An in-depth treatment of nonlinear programming and geometric programming with emphasis on both theory and applications.

Q.B.A. 540

*Mathematical Programming III* A seminar dealing with recent advances in mathematical programming.

Q.B.A. 550

*Dynamic Programming* Study of the concepts underlying model building and optimization of dynamic systems, with applications to engineering, economic, and environmental systems.

I.E. 519

Stat. 534 (M.E.R. 534)

*Goal Programming* Study of concepts and methods in analysis of systems involving multiple objectives, with applications to engineering, economic, and environmental systems.

I.E. 520

## PETROLEUM AND NATURAL GAS ENGINEERING

### PROCESSES AREA

*Inventory Models* A study of inventory theory, deterministic and probabilistic models, single and multiproduct models in single- and multistage processes.

I.E. 508

Op.Mgmt. 518

*Scheduling Models* Scheduling models with simultaneous job arrival and probabilistic job arrival, network scheduling, and scheduling simulation techniques.

I.E. 507

Op.Mgmt. 516

*Waiting Line Models* Theory of systems involving stochastic delay and stochastic service.

I.E. 509

### OPERATIONS RESEARCH (O R)

590: COLLOQUIUM (1-3)

## PETROLEUM AND NATURAL GAS ENGINEERING (PNG E)

C. DREW STAHL, *Section Chairman of Petroleum and Natural Gas Engineering*  
207 Mineral Sciences Building  
814-865-6082

**Degrees Conferred:** Ph.D., M.S.

#### **Senior Member of the Graduate Faculty**

C. Drew Stahl, Ph.D. (Penn State), P.E. *Professor of Petroleum and Natural Gas Engineering*

#### **Associate Members of the Graduate Faculty**

Turgay Ertekin, Ph.D. (Penn State) *Assistant Professor of Petroleum and Natural Gas Engineering*  
Robert H. Jacoby, M.S. (Michigan) *Associate Professor of Petroleum and Natural Gas Engineering*  
Mark A. Klins, Ph.D. (Penn State), P.E. *Assistant Professor of Petroleum and Natural Gas Engineering*

Areas of specialization include experimental and theoretical studies of water flooding and the newer methods for displacing oil from porous media, methods for calculating reservoir performance, scaled laboratory studies of reservoir phenomena, and drilling and well completion problems.

#### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Students who expect to enter graduate study in this program with a degree in another major should present 6 credits in geology, 15 in engineering science, and credit for mathematics through integral calculus. A limited number of deficiencies may be made up after admission.

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

#### **Degree Requirements**

Certain closely related courses outside the department may be counted as petroleum and natural gas credits toward the degree.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of one foreign language.



### Other Relevant Information

Students in this program may elect the dual-title degree program option in Operations Research for the Ph.D. and M.S. degrees (see p. 285).

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

**CONTINENTAL OIL COMPANY FELLOWSHIP** — Available to a graduate student in petroleum and natural gas engineering for studies in petroleum engineering; stipend variable.

**GULF OIL COMPANY FELLOWSHIP IN PETROLEUM AND NATURAL GAS ENGINEERING** — Available to a graduate student for work in petroleum production; stipend variable.

**TEXACO FELLOWSHIP IN EARTH AND MINERAL SCIENCES** — Available to a graduate student in the College of Earth and Mineral Sciences; stipend \$1,200-3,000 plus tuition.

### PETROLEUM AND NATURAL GAS (P N G)

- 410. APPLIED RESERVOIR ENGINEERING (3)
  - 420. APPLIED RESERVOIR ANALYSIS (3)
  - 421. RESERVOIR ENGINEERING (3)
  - 422. ROCK AND FLUID LABORATORY (1)
  - 425. PRINCIPLES OF WELL TESTING AND EVALUATION (3)
  - 430. RESERVOIR MODELING (3)
  - 440. FORMATION EVALUATION (3)
  - 450. DRILLING DESIGN AND PRODUCTION ENGINEERING (3)
  - 451. OIL WELL DRILLING LABORATORY (1)
  - 475. PETROLEUM ENGINEERING DESIGN (3)
  - 480. PRODUCTION PROCESS ENGINEERING (3)
  - 481. NATURAL GAS AND GASOLINE PLANTS (2)
  - 485. ENGINEERING IN SECONDARY RECOVERY (3)
  - 486. TERTIARY OIL RECOVERY METHODS (3)
  - 493. ENGINEERING EVALUATION OF OIL AND GAS PROPERTIES (3)
  - 494. THESIS (1-6)
510. SOLUTION OF THE PARTIAL DIFFERENTIAL EQUATIONS OF FLOW IN POROUS MEDIA (3) The application of mathematical techniques to solve the partial differential equations of steady and unsteady state flow in porous media. Prerequisite: Math. 405.
511. NUMERICAL SOLUTION OF THE PARTIAL DIFFERENTIAL EQUATIONS OF FLOW IN POROUS MEDIA (3) Differencing schemes for the partial differential equations of single-phase flow; application to flow of gas and mixing in porous media.
512. NUMERICAL RESERVOIR SIMULATION (3) Mathematical analysis of complex reservoir behavior and combination drives; numerical methods for the solution of behavior equations; recent developments. Prerequisite: P.N.G. 510.
513. ADVANCED NUMERICAL RESERVOIR SIMULATION (3) Compositional simulation; history-matching theory; simulation of basic processes involving heat and mass transfer in porous media. Prerequisite: P.N.G. 512.
514. OPTIMIZATION OF PETROLEUM RECOVERY PROCESSES (3) Optimum search methods, linear programming, nonlinear programming, dynamic programming, application to water flooding, depletion drive, steam injection, gas cycling, miscible displacement. Prerequisite: P.N.G. 410.
515. ADVANCED OIL RECOVERY TECHNIQUES (3) Advanced oil recovery techniques including water flooding, in situ combustion, steam injection, hot-water injection, and miscible-phase displacement.
519. DESIGN OF THERMAL RECOVERY PROJECTS (3) Suitability of reservoirs for thermal oil recovery; case histories; design of in situ combustion and steamfloods; thermal stimulation; shale oil recovery. Prerequisite: P.N.G. 515.

## PHARMACOLOGY

520. PHASE RELATIONS IN RESERVOIR ENGINEERING (3) Phase relations as applied to condensate and retrograde condensate reservoirs and to other problems in petroleum production.

530. NATURAL GAS ENGINEERING (1-3) Flow in producing or storage reservoirs; gas well testing; transmission systems; storage cycle; current developments. Prerequisite: P.N.G. 481.

550. ADVANCED ENGINEERING EVALUATION OF OIL- AND GAS-PRODUCING PROPERTIES (3) Selected topics of current research and development interest in formation evaluation, geophysical well logging, and production economics. Prerequisites: P.N.G. 440, 493.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

NOTE: *Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in petroleum and natural gas studies are listed under Materials Science.*

## PHARMACOLOGY (PHARM)

ELLIOT S. VESELL, *Chairman of the Department*  
The Milton S. Hershey Medical Center  
Hershey, PA 17033  
717-534-8285

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Cheston M. Berlin, M.D. (Harvard) *Professor of Pediatrics and Pharmacology*  
Karl H. Beyer, Jr., Ph.D. (Wisconsin) *Adjunct Professor of Pharmacology*  
John D. Connor, Ph.D. (Phila. Col. Pharmacy and Science) *Professor of Pharmacology*  
Paul J. Fritz, Ph.D. (Auburn) *Associate Professor of Pharmacology*  
Frank E. Greene, Ph.D. (Florida) *Associate Professor of Pharmacology*  
Samson T. Jacob, Ph.D. (Agra) *Professor of Pharmacology*  
Dennis W. Schneck, Ph.D. (Alberta) *Associate Professor of Medicine and Pharmacology*  
Walter B. Severs, Ph.D. (Pittsburgh) *Professor of Pharmacology*  
Elliot S. Vesell, M.D. (Harvard) *Evan Pugh Professor of Pharmacology, Genetics, and Medicine*

### Associate Members of the Graduate Faculty

Barry H. Dvorchik, Ph.D. (Florida) *Associate Professor of Obstetrics/Gynecology and Pharmacology*  
Dai K. Liu, Ph.D. (Alabama) *Assistant Professor of Pharmacology*  
Thomas A. Lloyd, Ph.D. (Harvard) *Associate Professor of Obstetrics/Gynecology and Pharmacology*  
John R. Luderer, M.D. (Northwestern) *Assistant Professor of Medicine and Pharmacology*  
G. Thomas Passananti, Ph.D. (Penn State) *Assistant Professor of Pharmacology*  
Kathleen M. Rose, Ph.D. (Penn State) *Associate Professor of Pharmacology*  
Robert S. Sloviter, Ph.D. (Penn State) *Assistant Professor of Pharmacology*  
Joan Y. Summy-Long, Ph.D. (Penn State) *Assistant Professor of Pharmacology*  
Robert M. Ward, M.D. (Johns Hopkins) *Assistant Professor of Pediatrics and Pharmacology*

The graduate studies program in Pharmacology is designed to give qualified students a combination of didactic instruction, informal direction, and laboratory experience which will enable them to obtain a firm foundation in the principles, methods, and contributions of pharmacology (defined broadly as the science of the multiple aspects of the interaction of chemical agents with biological systems). With this preparation, graduates of the program should be capable of designing and executing high-quality independent research, and of assuming positions of responsibility within the pharmacologic community.

The department offers studies in the general areas of drug metabolism, molecular pharmacology, endocrine pharmacology, neuropharmacology, cardiovascular-renal pharmacology, and clinical pharmacology. Primary emphasis is placed on the molecular mechanism by which drugs act in the body and by which the body transforms drugs.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for*



*admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in the program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

A bachelor's degree reflecting a reasonable background in zoology or biology, mathematics, and chemistry is required. Reading knowledge of one or two foreign languages is recommended. Students with a minimum junior-senior average of 3.00 and with appropriate course backgrounds will be considered for admission. Two letters of recommendation, a curriculum vitae, and a description of career goals are required. Candidates usually enter the doctoral program directly, but they may be admitted into the master's program depending on their career aspirations.

### **Master's Degree Requirements**

A minimum of 30 credits as specified by the Graduate School are required. Candidates must submit a thesis based on original laboratory observations. There are no communication or language requirements. A specified core curriculum includes the following courses: B.Chem. 502, 505; Phsio. 520, 521; Pharm. 501, 502, 571, 590. Candidates must defend their dissertations to the satisfaction of the graduate faculty (two-thirds favorable vote).

### **Doctoral Degree Requirements**

Students will demonstrate skills in one of the following areas of communications: computer language, biostatistics, or a foreign language (usually French, German, or Russian). A specified core curriculum includes the following courses: B.Chem. 502, 505; Phsio. 520, 521; Pharm. 501, 502, 520, 571, 590, 596 (experience in three to six different laboratories). Students take for credit at least two elective courses in specialized areas of pharmacology and are encouraged to elect courses given by other departments at The Milton S. Hershey Medical Center. As an independent exercise, doctoral candidates will prepare a formal grant proposal for faculty review.

### **Other Relevant Information**

Each new graduate student is assigned an adviser *pro tem* who will serve as a general counselor. Master's candidates have three months from initial registration to form an agreement with a member of the graduate faculty who will supervise their laboratory work. Doctoral candidates can take as much as a year to form this agreement.

### **Student Aids**

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## **PHARMACOLOGY (PHARM)**

501. PHARMACOLOGY (4) Lectures, discussions, and laboratory study of the mechanism of drug action in biological systems.

502. PHARMACOLOGY (4) Continuation of Pharm. 501.

504. DRUG METABOLISM (3) Study of chemical transformation of drugs within animal cells and drug-metabolizing enzymes present in liver microsomes performing this function. Prerequisite: Pharm. 501.

505. PHARMACOKINETICS (3) Quantitation of the time courses of absorption, distribution, metabolism, and excretion of drugs in the intact organism. Prerequisite: Pharm. 501, 502, or 520.

510. MOLECULAR TURNOVER IN ANIMALS (3) In-depth consideration of the dynamic state of body constituents as applied to carbohydrates, lipids, nucleic acids, and particularly to proteins. Prerequisite: B.Chem. 502.

511. MOLECULAR MECHANISM OF ACTION OF DRUGS (2) Series of lectures and informal discussion on the molecular mechanism of action of some drugs and their clinical applications. Prerequisite: B.Chem. 502.

512. CLINICAL PHARMACOLOGY (3) Drug therapy of cardiovascular, renal, and neural diseases.

515. HUMAN GENETICS (2) Seminar-type presentations by students and staff on fundamental problems and current topics in human genetics.

520. PRINCIPLES OF DRUG ACTION (2) Detailed analysis of basic parameters governing drug actions.

## PHILOSOPHY

525. **PHARMACOLOGY OF ANTITUMOR DRUGS (2)** Study of the mechanisms of antitumor drug action in biological systems. Prerequisite: Pharm. 501.
530. **PHARMACOLOGY OF PSYCHOTROPIC DRUGS (2)** Systematic analysis of the effects of psychotropic drugs.
540. **PHARMACOGENETICS (3)** Study of human responses to individual drugs.
549. **NEURAL SUBSTRATES FOR DRUG ACTION (2)** Correlation of the sites of action within the central nervous system where certain common drugs exert major effects. Prerequisites: Pharm. 501, 502.
550. **NEUROPHARMACOLOGY (2)** Study of mechanisms of action of drugs which alter neuronal transmission in the peripheral and central nervous systems.
571. **TECHNIQUES IN PHARMACOLOGICAL RESEARCH (2)** Classes will be comprised of lectures by the faculty of the Department of Pharmacology, followed by working demonstrations of the techniques.
575. **DEVELOPMENT OF RENAL DRUGS (3)** The development and clinical application of new therapeutic agents, using one or more prototype drugs as examples. Prerequisites: Pharm. 501, 502.
590. **COLLOQUIUM (1-3)**
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**

## PHILOSOPHY (PHIL)

CARL R. VAUGHT, *Head of the Department*  
246 Sparks Building  
814-865-6397

**Degrees Conferred:** Ph.D., M.A.

### Senior Members of the Graduate Faculty

Joseph C. Flay, Ph.D. (Southern California) *Associate Professor of Philosophy*  
Carl R. Hausman, Ph.D. (Northwestern) *Professor of Philosophy*  
Henry W. Johnstone, Jr., Ph.D. (Harvard) *Professor of Philosophy*  
Joseph J. Kockelmans, Ph.D. (Institute of Medieval Studies, Angelicum, Rome) *Professor of Philosophy*  
Alphonso F. Lingis, Ph.D. (Louvain) *Professor of Philosophy*  
Stanley H. Rosen, Ph.D. (Chicago) *Professor of Philosophy*  
Thomas M. Seeböhm, Dr.Phil.habil. (Mainz) *Professor of Philosophy*  
Carl G. Vaught, Ph.D. (Yale) *Associate Professor of Philosophy*

### Associate Members of the Graduate Faculty

Richard A. Cohen, Ph.D. (S.U.N.Y., Stony Brook) *Assistant Professor of Philosophy*  
Robert E. Ginsberg, Ph.D. (Pennsylvania) *Professor of Philosophy*  
Emily R. Grosholz, Ph.D. (Yale) *Assistant Professor of Philosophy*  
Glen H. Helman, Ph.D. (Pittsburgh) *Assistant Professor of Philosophy*  
Nancy F. McKenzie, Ph.D. (S.U.N.Y., Stony Brook) *Assistant Professor of Philosophy*  
Robert G. Price, Ph.D. (Yale) *Associate Professor of Philosophy*  
Albert G. Tsugawa, Ph.D. (Michigan) *Associate Professor of Philosophy*

A thorough grounding in the history of philosophy is desirable for all students. Specialization is possible in areas (such as aesthetics, metaphysics, ethics, social philosophy, logic, and history and philosophy of science); in movements of thought (such as rationalism, empiricism, idealism, phenomenology, and existentialism); or in any of the major figures in the history of Western philosophy. Specialization is also possible in a joint program with the Department of Mathematics in logic and the foundations of mathematics, and with the Department of Physics in philosophy of science.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the*



*APPLICATION AND ADMISSION* section of the *Graduate Bulletin*.) Requirements listed below are in addition to general Graduate School requirements stated in the *GENERAL INFORMATION* section of the *Graduate Bulletin*.

Undergraduate preparation to the extent of a strong minor is advisable.

Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

#### **Degree Requirements**

The department may waive the requirement of a thesis for an M.A. candidate. The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of two foreign languages or by comprehensive knowledge of one.

#### **Student Aids**

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the *Graduate Bulletin*, the following awards typically have been available to graduate students in this program:

EDWIN ERLE SPARKS DISSERTATION FELLOWSHIP IN THE HUMANITIES — Available to a doctoral candidate in one of the following graduate programs: classics, comparative literature, English, French, German, history, linguistics, philosophy, religious studies, Slavic languages and literatures, Spanish, and speech communication; stipend \$4,800 plus tuition. Apply to relevant department or program before February 1.

EDWIN ERLE SPARKS FELLOWSHIPS IN THE HUMANITIES (8) — Available to beginning graduate students in one of the following graduate programs: classics, comparative literature, English, French, German, history, linguistics, philosophy, religious studies, Slavic languages and literatures, Spanish, and speech communication; stipends \$3,800 plus tuition. Apply to relevant department or program before February 1.

#### **PHILOSOPHY (PHIL)**

- 403. ENVIRONMENTAL ETHICS (3)
- 408. SOCIAL AND POLITICAL PHILOSOPHY (3)
- 413. PHILOSOPHY OF LITERATURE (3)
- 414. AESTHETICS (3)
- 419. AMERICAN PHILOSOPHY (3)
- 421. PHILOSOPHY OF SCIENCE (3)
- 424. PHILOSOPHY OF RELIGION (3)
- 425. THEORY OF KNOWLEDGE (3)
- 426. METAPHYSICS (3-6)
- 427. ETHICS (3)
- 429. PHILOSOPHY OF LANGUAGE (3)
- 432. (S.T.S. 432) MEDICAL ETHICS (3)
- 433. ETHICS AND THE ENGINEER (3)
- 435. (S.T.S. 435) THE INTERRELATION OF SCIENCE, PHILOSOPHY, AND RELIGION (3)
- 440. (Ph.Ed. 440) PHILOSOPHY AND SPORT (3)
- 443. PHILOSOPHY OF MATHEMATICS (3)
- 449. PHILOSOPHICAL LOGIC (3)
- 450. PRE-SOCRATIC PHILOSOPHY (3-6)
- 451. PLATO (3-6)
- 452. ARISTOTLE (3-6)
- 460. STUDIES IN MEDIEVAL PHILOSOPHY (3)
- 470. CONTINENTAL RATIONALISM (3-6)
- 471. BRITISH EMPIRICISM (3-6)
- 472. ENLIGHTENMENT PHILOSOPHY (3-6)
- 473. VICO (3-6)
- 474. KANT (3-6)
- 475. FICHTE AND SCHELLING (3-6)
- 476. HEGEL (3-6)
- 480. MARX (3-6)

## PHILOSOPHY

- 481. NIETZSCHE (3-6)
- 482. PEIRCE (3-6)
- 483. CASSIRER (3-6)
- 484. HUSSERL (3-6)
- 485. HEIDEGGER (3-6)
- 486. WITTGENSTEIN (3-6)
- 487. ANALYTIC PHILOSOPHY (3-6)
- 488. CONTEMPORARY FRENCH PHILOSOPHY (3-6)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
- 499. FOREIGN STUDY — PHILOSOPHY (1-12)
  
- 500. ETHICS: HISTORICAL AND SYSTEMATIC (2-6) Critical study of some problem of ethical theory, or of some period of the history of ethics.
- 504. SOCIAL AND POLITICAL PHILOSOPHY (3-6) Critical study of basic problems in their historical and functional setting.
- 509. SEMINAR IN CONTEMPORARY PHILOSOPHY (3-6) Men and movements in twentieth-century philosophy.
- 512. ADVANCED TOPICS IN PHILOSOPHY OF SCIENCE (3-6) Crucial problems in the theory of science and scientific method.
- 513. (Psy. 513) PRINCIPLES AND METHODS OF EMPIRICAL SCIENCE (3) Scientific methodologies and their presuppositions, with special emphasis on behavioral and social sciences.
- 514. NINETEENTH-CENTURY PHILOSOPHY (3-6) Study of a philosopher or philosophical movement of the nineteenth century.
- 516. SEMINAR IN AESTHETICS (3-6) Problems and theories in the nature of art.
- 526. SEMINAR IN METAPHYSICS (3-6) Formulation and analysis of metaphysical problems in the various fields of philosophy.
- 543. FIRST-ORDER LOGIC (3) Logical theory and metatheory for truth-functions, quantifiers, and identity.
- 550. SEMINAR IN PLATO (3 per semester, maximum of 6) Analysis of a major Platonic dialog.
- 551. SEMINAR IN ARISTOTLE (3 per semester, maximum of 6) Analysis of a major Aristotelian treatise.
- 560. SEMINAR IN MEDIEVAL PHILOSOPHY (3 per semester, maximum of 6) Study of the works of a leading thinker in the Middle Ages, such as Augustine, Anselm, Aquinas, or Ockham.
- 570. SEMINAR IN CONTINENTAL RATIONALISM (3 per semester, maximum of 6) Topics in continental rationalism. At certain points, the interpretations will refer to the Latin and French originals.
- 571. SEMINAR IN BRITISH EMPIRICISM (3 per semester, maximum of 6) Seminar devoted to a major figure or topic in the British tradition from Bacon to Mill.
- 572. SEMINAR IN KANT (3 per semester, maximum of 6) Aspects of Kant's philosophy. At certain points, the interpretations will refer to the German original.
- 573. SEMINAR IN HEGEL (3 per semester, maximum of 6) Study of some Hegelian text; relevant scholarship and criticism. At certain points, the interpretations will refer to the German original.
- 580. PHENOMENOLOGY (3 per semester, maximum of 6) A critical study of one or more thinkers, ideas or movements in modern phenomenology.
- 581. HERMENEUTICS (3 per semester, maximum of 6) Hermeneutic philosophy and aspects of its methodological significance for human studies, philology, history, sociology and psychology, and philosophy of science.
- 582. CONTEMPORARY EUROPEAN PHILOSOPHY (3 per semester, maximum of 6) Husserl's phenomenology and Heidegger's existence philosophy; structuralist and critical Marxism; Gadamer and hermeneutics; Derrida and metaphysical deconstruction.



583. **ANGLO-AMERICAN PHILOSOPHY** (3 per semester, maximum of 6) The methods of contemporary philosophical analysis. Readings from Russell, Quine, Wittgenstein, Austin, Strawson, and related writers.
590. **COLLOQUIUM** (1-3)
594. **RESEARCH TECHNIQUE** (1) A course utilizing research sources and techniques relevant to philosophical studies. Taken in the first semester of graduate study.
596. **INDIVIDUAL STUDIES** (1-9)
597. **SPECIAL TOPICS** (1-9)
602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING** (1-3 per semester, maximum of 6)

## PHYSICAL EDUCATION (PH ED)

JAMES G. THOMPSON, *Acting Head of the Department*  
1 White Building  
814-863-0353

**Degrees Conferred:** Ph.D., D.Ed., M.S., M.Ed.

### Senior Members of the Graduate Faculty

Elsworth R. Buskirk, Ph.D. (Minnesota) *Professor of Applied Physiology*  
Peter R. Cavanagh, Ph.D. (Royal Free Medical) *Professor of Biomechanics*  
Robert W. Christina, Ph.D. (Maryland) *Professor of Physical Education*  
Dorothy V. Harris, Ph.D. (Iowa) *Professor of Physical Education*  
James L. Hodgson, Ph.D. (Minnesota) *Associate Professor of Applied Physiology*  
Eliezer Kamon, Ph.D. (Hebrew, Jerusalem) *Professor of Applied Physiology and Ergonomics*  
John A. Lucas, Ed.D. (Maryland) *Professor of Physical Education*  
Herberta M. Lundegren, Ph.D. (Iowa) *Professor of Physical Education*  
Jose de la Vega Mendez, Ph.D. (Minnesota) *Professor of Health and Applied Physiology*  
Chauncey A. Morehouse, Ph.D. (Penn State) *Professor of Physical Education*  
Richard C. Nelson, Ph.D. (Michigan State) *Professor of Physical Education*  
John B. Shea, Ph.D. (Michigan) *Associate Professor of Physical Education*  
Ronald A. Smith, Ph.D. (Wisconsin) *Professor of Physical Education*  
Karl G. Stoenefalke, Ph.D. (Illinois) *Professor of Physical Education*

### Associate Members of the Graduate Faculty

James D. Gallagher, Ph.D. (Penn State) *Associate Professor of Physical Education*  
Joseph L. Loomis, M.S. (Penn State) *Research Associate in Applied Physiology*  
Lucille I. Magnusson, Ph.D. (Iowa) *Professor of Physical Education*  
W. Channing Nicholas, M.D. (Pennsylvania) *Associate Professor of Applied Physiology*  
Ralph J. Sabock, Ph.D. (Ohio State) *Associate Professor of Physical Education*  
Robert J. Scannell, Ph.D. (Penn State) *Professor of Physical Education*  
James G. Thompson, Ph.D. (Penn State) *Associate Professor of Physical Education*

The graduate programs in Physical Education are research oriented and are designed to meet the specific goals and interests of the student. The primary goal of the program is to provide students the opportunity to study in depth in one of the areas of specialization and to develop necessary research skills to enhance their professional competence. The master's program is designed to prepare students for future graduate study, while the doctoral program is directed toward careers in research and in teaching at the advanced undergraduate and graduate levels in colleges and universities. The areas of specialization available at the master's level only include (1) administration and curriculum, (2) exercise specialist, (3) performance assessment, and (4) sports administration. The programs available at both the master's and doctoral levels are (1) adapted physical education, (2) biomechanics, (3) history of sport and physical education, (4) motor learning and control, (5) physiology of exercise, and (6) sport psychology. Several well-equipped research facilities are available to support graduate study including the Biomechanics Laboratory, Motor Behavior Laboratory, Noll Laboratory for Human Performance Research, Sports Research Institute, and the Center for Women and Sport.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in the program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

The minimum requirements for admission to the master's program include 3.00 junior-senior grade-point average, satisfactory recommendations, a total of 1,000 or higher on the verbal and quantitative sections of the GRE, and appropriate background courses in physical, biological, behavioral, and/or social science depending on the intended area of specialization. Applicants for all specializations except sports administration must have had courses in exercise physiology, kinesiology/biomechanics, history/philosophy/sociology of sport, motor learning, and sport psychology. Deficiencies in these areas must be completed before the degree is conferred and credits generally will not be applied to those required for graduation. Candidates from majors other than physical education are welcome to apply, but additional courses will be required. In addition, doctoral applicants need a 3.50 average in a master's degree program, plus documented research capabilities. Experience is highly desirable. A master's degree is required prior to acceptance to the doctoral program. The best-qualified applicants will be accepted up to the number of spaces available for new students. Applicants who do not meet established criteria may be considered on an individual basis.

### Master's Degree Requirements

All master's candidates are required to complete a research methods course and an acceptable statistics course; show proficiency in the English language; and write a thesis. In addition, each specialization may require specific courses. The sports administration specialization requires a minimum of 34 credits. All other specializations require a minimum of 30 credits.

### Doctoral Degree Requirements

Core requirements for all doctoral candidates include a minimum of 6 credits of statistics in sequence, research methods course, master's thesis, familiarity with use of computers, a graduate student seminar, and a foreign language at the intermediate level of comprehension. The foreign language requirement may be waived for D.Ed. candidates on the recommendation of the student's committee. The candidacy and comprehensive examinations include both written and oral sections.

Each student is assigned an adviser in the identified area of specialization. Quotas are established for each specialization resulting in a low student-adviser ratio. At the doctoral level students work closely with their adviser on research projects and, in most cases, on the development of grant proposals and in supervised teaching experiences.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## PHYSICAL EDUCATION (PH ED)

- 400. ADAPTED PHYSICAL EDUCATION (3)
- 402. PHYSICAL ACTIVITIES FOR CHILDREN IN SPECIAL EDUCATION (3)
- 412. CONTEMPORARY PROBLEMS OF TEACHING PHYSICAL EDUCATION IN THE INNER CITY SCHOOLS (3)
- 420. PSYCHOSOCIAL DIMENSIONS OF PHYSICAL ACTIVITY (3)
- 424. THE FEMALE IN EXERCISE AND SPORT (3)
- 440. (Phil. 440) PHILOSOPHY AND SPORT (3)
- 441. HISTORY OF SPORT IN AMERICAN SOCIETY (3)
- 442. SPORT IN ANTIQUITY (3)
- 443. THE MODERN OLYMPIC GAMES (3)
- 452. METHODS, MATERIALS, AND PRINCIPLES OF PHYSICAL EDUCATION IN THE ELEMENTARY SCHOOL (3)
- 455. STATISTICAL METHODS IN HEALTH, PHYSICAL EDUCATION, AND RECREATION (3)
- 456. PHYSICAL FITNESS APPRAISAL (3)
- 457. EXERCISE PRESCRIPTION (2)
- 463. ACQUISITION OF MOTOR SKILLS (3)



470. HISTORY AND THEORY OF DANCE IN EDUCATION (2)
473. ADVANCED MODERN DANCE I (1)
474. ADVANCED MODERN DANCE II (1)
480. EXERCISE PHYSIOLOGY (3)
483. MOTOR PATTERNS OF CHILDREN (3)
484. SPORT BIOMECHANICS (3)
489. INTRAMURAL ATHLETICS (3)
490. MEASUREMENT AND EVALUATION IN HEALTH AND PHYSICAL EDUCATION (2)
491. ORGANIZATION AND ADMINISTRATION OF HEALTH AND PHYSICAL EDUCATION IN SCHOOLS (2)
493. METHODS AND PRINCIPLES OF ATHLETIC COACHING (2)
- 495A. PRACTICUM IN STUDENT TEACHING (10)
- 495B. FIELD AND/OR RESEARCH PRACTICUM IN PHYSICAL EDUCATION (3-10)
496. INDEPENDENT STUDIES (1-18)
497. SPECIAL TOPICS (1-9)
500. (Rc.Pk. 500) INDIVIDUAL STUDY AND RESEARCH PROJECTS (1-10) Prerequisite: Ph.Ed. 530.
520. PSYCHOLOGY OF SPORT (3) Study of man's psychological behavior in sport and physical activity; development of somatopsychic theory of physical activity. Prerequisites: 6 credits in psychology.
522. SPORT IN SOCIETY (3) Examination of the cultural phenomenon of sport; social behavior in sport; institution of sport and relationship with other social institutions. Prerequisite: 3 credits in sociology.
525. SOCIAL PSYCHOLOGY OF SPORT (3) Theory and research concerning the social-psychological basis for understanding social interaction and performance in team and individual sport settings. Prerequisite: 3 credits in social psychology at the 400 or 500 level.
530. (Hl.Ed. 530, Rc.Pk. 530) RESEARCH TECHNIQUES IN HEALTH AND PHYSICAL EDUCATION AND RECREATION (3) Research techniques, including methods, research design, techniques for data collection, as applied to relevant problems in the health education field.
532. TESTS AND MEASUREMENTS IN PHYSICAL EDUCATION (3) Critical study of tests and measurements available in physical education; methods of constructing and evaluating new tests and measurements. Prerequisite: Ph.Ed. 490.
534. STUDIES IN CURRICULUM CONSTRUCTION IN PHYSICAL EDUCATION (3) Principles and methods of curriculum building in physical education; different psychological and educational points of view, organizing a course of study committee, making units of instruction.
535. MODERN FOREIGN SYSTEMS OF SPORT AND PHYSICAL EDUCATION (3) Comparative analysis of national and local programs and systems of physical education in foreign countries.
550. SEMINAR IN HEALTH AND PHYSICAL EDUCATION (1-6) An in-depth analysis of current problems confronting the profession.
555. INTERNSHIP IN SPORT ADMINISTRATION (3-10) A supervised internship in the administration of interscholastic, intercollegiate, professional sport, or commercial sport-related enterprises. Prerequisites: 14 credits in sport administration, curriculum supervision area of specialization.
560. ADMINISTRATIVE PROBLEMS OF PHYSICAL EDUCATION IN SCHOOLS (3) Solutions to problems emerging from the administration of physical education in schools, fitting physical education in the school's schedule, awards, and budgets. Prerequisite: Ph.Ed. 491.
563. MOTOR LEARNING (3) Analysis of research evidence related to motor skills; characteristics of beginning and advanced performers; relevant learning principles.
565. NEUROMUSCULAR PERFORMANCE (3) Integrative action of the neural and muscular systems in effecting human movement with emphasis on motor performance. Prerequisite: Ph.Ed. 480.
567. (Phsio. 567) ADVANCED EXERCISE PHYSIOLOGY (3) Physiological changes during exercise with emphasis on the effects of physical conditioning and training. Prerequisites: Biol. 472, Ph.Ed. 480.
568. (Phsio. 568) ERGONOMICS (3) Anthropometric, biomechanical, and physiological characteristics of working man and their importance in the man-machine-environment complex. Prerequisites: Biol. 472, Ph.Ed. 480; I.E. 408 recommended for engineering students.

## PHYSICS

575. **MOTOR PERFORMANCE OF THE HANDICAPPED (3)** Motor performance of physically handicapped and mentally retarded. Activities and therapeutic exercises for the formulation of individualized programs. Prerequisites: Cn.Ed. 409, Spl.Ed. 410.
576. **INTERNSHIP IN ADAPTED PHYSICAL EDUCATION (3)** Supervised internship in recreational, educational, or clinical situations; assessment of motor performances, evaluation of activities, and staff conference participation.
577. (Phsio. 577) **APPLIED CARDIOVASCULAR PHYSIOLOGY (2)** In-depth study of cardiovascular system physiology. Prerequisite: 4 credits in physiology at the 400 or 500 level.
580. (Phsio. 580) **ANALYSIS OF BODY COMPOSITION (2)** Study of the methods employed in the analysis of body composition. Prerequisite: Biol. 472 or 3 credits in physiology at the 400 or 500 level.
581. **BIOMECHANICS (3)** Kinetic and kinematic analyses of human motion utilizing electromyography and stroboscopic-photographic techniques. Prerequisites: Ph.Ed. 480, 484.
582. **SPORT BIOMECHANICS (3)** Analysis of sports movements utilizing cinematography, electronic devices, and related research instruments.
584. **ELECTROMYOGRAPHIC KINESIOLOGY (3)** The theoretical background and practical application of electromyography in understanding human movement and the function of muscles. Prerequisites: Ph.Ed. 480, 484.
585. (Phsio. 585) **APPLIED PHYSIOLOGY: THERMAL (3)** Physiological mechanisms activated by exposure to environmental temperature. Prerequisite: Ph.Ed. 480 or 3 credits in physiology at the 400 or 500 level.
586. (Phsio. 586) **RESEARCH METHODS IN APPLIED PHYSIOLOGY (3)** Historical and current procedures for evaluation of cardio-pulmonary function, metabolism, and thermal balance in man; lecture, demonstration, and student laboratory. Prerequisite: 3 credits in physiology at the 400 or 500 level.
587. (Phsio. 587) **APPLIED PHYSIOLOGY: AMBIENT PRESSURE (3)** Physiological mechanisms activated by exposure to environmental pressure. Prerequisite: Ph.Ed. 480 or 3 credits in physiology at the 400 or 500 level.
590. **COLLOQUIUM (1-3)**
595. **PHILOSOPHY OF SPORT AND PHYSICAL EDUCATION (3)** Principles underlying sport and physical education and the meaning of these phenomena in individual lives. Prerequisite: Ph.Ed. 491 or Rc.Pk. 465 or 3 credits of philosophy.
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**
602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)**

## PHYSICS (PHYS)

S. MATSUSHIMA (*Head, Department of Astronomy*), *Acting Head of the Department*  
104 Davey Laboratory  
814-865-7533

**Degrees Conferred:** Ph.D., D.Ed., M.S., M.Ed.

### Senior Members of the Graduate Faculty

Gerhard R. Barsch, Dr.rer.nat. (Göttingen) *Professor of Physics*  
Milton W. Cole, Ph.D. (Chicago) *Professor of Physics*  
Paul H. Cutler, Ph.D. (Penn State) *Professor of Physics*  
T. Emanuel Feuchtwang, Ph.D. (Stanford) *Professor of Physics*  
Gordon N. Fleming, Ph.D. (Pennsylvania) *Professor of Physics*  
Daniel R. Frankl, Ph.D. (Columbia) *Professor of Physics*  
Norman Freed, Ph.D. (Case Western Reserve) *Professor of Physics*  
Roland H. Good, Jr., Ph.D. (Michigan) *Professor of Physics*  
Reinhard Graetzer, Ph.D. (Wisconsin) *Associate Professor of Physics*  
Howard Grotch, Ph.D. (Cornell) *Professor of Physics*  
Heinz K. Henisch, Ph.D. (Reading) *Professor of Physics*



Roger M. Herman, Ph.D. (Yale) *Professor of Physics*  
 Emil Kazes, Ph.D. (Chicago) *Professor of Physics*  
 Bruce R. F. Kendall, Ph.D. (Western Australia) *Professor of Physics*  
 L. George Lang, Ph.D. (Carnegie Tech.) *Professor of Physics*  
 Jeffrey S. Lannin, Ph.D. (Stanford) *Associate Professor of Physics*  
 A. Hamid Madjid, Dr.Sc.Nat. (Swiss Fed. Inst. of Tech.) *Associate Professor of Physics*  
 Robert D. McCammon, D.Phil. (Oxford) *Associate Professor of Physics*  
 T. King McCubbin, Jr., Ph.D., (Johns Hopkins) *Professor of Physics*  
 Josef Pliva, Dr.Tech. (Technical, Prague) *Professor of Physics*  
 Santiago R. Polo, Ph.D. (Madrid) *Professor of Physics*  
 William W. Pratt, Ph.D. (Iowa State) *Professor of Physics*  
 Robert W. Reed, Ph.D. (Penn State) *Assistant Professor of Physics*  
 Peter B. Shaw, Ph.D. (Carnegie Tech.) *Associate Professor of Physics*  
 Greenville K. Strother, Ph.D. (Penn State) *Professor of Biophysics*  
 Thomas T. Thwaites, Ph.D. (Rochester) *Associate Professor of Physics*  
 Tien-Tzou Tsong, Ph.D. (Penn State) *Professor of Physics*  
 Kuppuswamy Vedam, Ph.D. (Saugor) *Professor of Physics*  
 Thomas A. Wiggins, Ph.D. (Penn State) *Professor of Physics*

#### **Associate Members of the Graduate Faculty**

Moses H. W. Chan, Ph.D. (Cornell) *Assistant Professor of Physics*  
 Julian D. Maynard, Ph.D. (Princeton) *Assistant Professor of Physics*  
 Don N. Page, Ph.D. (California Tech.) *Assistant Professor of Physics*

Graduate instruction and research opportunities are available in atomic and molecular physics, nonlinear optics, field emission and field ion microscopy, many aspects of solid-state and surface physics, low-temperature physics, ionosphere and vacuum physics, acoustics, physics of biological compounds, nuclear physics, theoretical particle physics, quantum field theory, and general relativity. Work in some areas is conducted in cooperation with the Materials Research Laboratory, the Ionosphere Research Laboratory, and the Applied Research Laboratory. Thesis research toward the applied M.S. degree and the applied option of the Ph.D. degree is usually carried out in one of these laboratories.

#### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in the program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

A bachelor's degree in physics or an allied field is required for admission to the M.S., D.Ed., and Ph.D. programs. Students with a 2.50 or higher junior-senior average in physics and mathematics will be considered, and the best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests. Exceptions may also be made for applicants for doctoral programs who have completed master's degrees at other institutions.

Admission and study programs for the M.Ed. degree are handled on an individual basis.

#### **Master's Degree Requirements**

Standard M.S. program: Required courses include Phys. 525, 530, 532, 557, 559 (1 credit), 561 or 410. There are two options. Thesis option: The thesis must be based on at least 6 credits of Phys. 600 and must conform to Graduate School regulations. Nonthesis option: An additional 6 credits of 500-level Physics courses beyond the required ones must be taken, and a short paper must be submitted to, and accepted by, the department. There is no degree examination for either option.

M.S. program in applied physics: This program has prerequisites of junior/senior level courses in electricity and magnetism, mechanics, electronics, thermodynamics, optics, solid state physics, and computer programming. Required courses include advanced courses in electricity and magnetism and electronics, a 2-credit graduate laboratory course, a seminar series, and a course in quantum mechanics. In addition to these, two courses must be chosen from the areas of semiconductors, vacuum and electron physics, advanced optics, and acoustics; and at least two courses in the areas of properties of materials, space science, metallurgy, polymers, energy conservation, plasmas or fuel science, and atomic or molecular physics. Thesis research will start no later than the second semester and will be reported in a conventional master's thesis.

## PHYSICS

**M.Ed. program:** At least 18 credits in physics are required, of which up to 6 credits may be for research. Six additional nonresearch science credits (which may be in physics) and a 6-credit minor in education also must be included. A thesis or term paper must be submitted and accepted by the department.

### Doctoral Degree Requirements

**Ph.D. program:** Required courses include Phys. 517, 525, 530, 532, 557, 558, 559 (1 credit), 561, 562, and a first-year seminar series. Courses required beyond these depend on the Ph.D. option. Those who choose the standard option take at least four additional 3-credit, 500-level physics courses. Those who choose the applied physics option take at least four additional courses of an applied nature selected from a list which will be provided by the physics department on request.

A candidacy examination is given at the end of the first year, a comprehensive examination approximately two years after the candidacy examination, and a final thesis defense takes place after the completion of the thesis. There is no departmental foreign language requirement although a reading knowledge of one foreign language may be needed in some areas of research.

**D.Ed. program:** The requirements and procedures are the same as those for the Ph.D. program except for the following changes. Only two 500-level physics courses are required after the first ten courses listed above. An educational minor of at least 15 credits is required. A total of 90 credits must be earned in graduate school, at least 30 in residence. The thesis must be based on a minimum of 15 research credits.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following award typically has been available to graduate students in this program:

**WHEELER P. DAVEY MEMORIAL FELLOWSHIPS** — Carry a variable stipend and are available to a limited number of graduate students in physics.

### PHYSICS (PHYS)

- 400. INTERMEDIATE ELECTRICITY AND MAGNETISM (4)
- 402. ELECTRONICS FOR SCIENTISTS (4)
- 406. NUCLEAR PHYSICS (3)
- 410. INTRODUCTION TO QUANTUM MECHANICS (3)
- 412. SOLID STATE PHYSICS I (3)
- 413. SOLID STATE PHYSICS II (3)
- 419. (Math. 419) THEORETICAL MECHANICS (3)
- 420. THERMODYNAMICS (3)
- 421. KINETIC THEORY AND STATISTICAL MECHANICS (3)
- 443. INTERMEDIATE ACOUSTICS (3)
- 454. ATOMIC AND NUCLEAR PHYSICS (3)
- 457. EXPERIMENTAL PHYSICS (1-2 per semester)
- 458. INTERMEDIATE OPTICS (4)
- 461. (Math. 461) THEORETICAL MECHANICS (3)
- 467. INTERMEDIATE ELECTRICITY AND MAGNETISM (3)
- 471. QUANTUM THEORY OF ATOMS AND MOLECULES (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 510. GENERAL RELATIVITY (3) Foundations of general relativity; physics of metric spaces, tensor calculus; particle dynamics. Applications to stellar structure and cosmology. Prerequisites: Phys. 530; Phys. 525 or Math. 523.
- 511. APPLICATIONS OF GENERAL RELATIVITY (3) Einstein's equations; empty and matter-filled spaces; conservation laws; Schwarzschild, Nordström-Reissner, and Kerr solutions; solar system tests; gravitational waves. Prerequisite: Phys. 510.
- 512-513. INTRODUCTION TO THE QUANTUM THEORY OF SOLIDS (3 each) Energy band theory; electrical, optical, and magnetic properties; lattice dynamics; transport theory. Prerequisites: Phys. 412, 517.



517. **STATISTICAL MECHANICS (3)** Classical and quantum statistics; statistical thermodynamics; the Boltzmann transport equation; methods illustrated with applications to physical problems. Prerequisites: Phys. 420, 561.

518. **ADVANCED TOPICS IN THERMODYNAMICS AND STATISTICAL MECHANICS (3)** Selected topics related to nonequilibrium thermodynamics, many-body problem, fluctuations, and statistical theory of random processes. Prerequisite: Phys. 517.

524. **PHYSICS OF SEMICONDUCTORS (3)** Band structures, theory of electron and hole conduction, transport properties, excess carrier distributions, p-n junctions, metal-semiconductor contacts, semiconductor surfaces. Prerequisite: Phys. 412.

525. **METHODS OF THEORETICAL PHYSICS (3)** Calculus of variations, ordinary differential equations, complex variables, numerical methods as applied to problems in theoretical physics.

530. **THEORETICAL MECHANICS (3)** Newtonian mechanics, noninertial coordinate system, Lagrangian mechanics, small oscillations, rigid body motion, Hamiltonian mechanics.

532. **THEORETICAL CONTINUUM MECHANICS (3)** Wave phenomena, hydrodynamics, heat conduction, elastic continua. Prerequisite: Phys. 530.

533. **THEORETICAL ACOUSTICS (3)** Vibrating systems; transmission of disturbances through elastic and viscoelastic media. Prerequisite: Phys. 530.

550. **APPLIED GROUP THEORY (3)** Representations of discrete and continuous groups, applications to theoretical physics and differential equations, varying emphasis on the specific applications. Prerequisite: Phys. 525.

553-554. **NUCLEAR PHYSICS (3 each)** Theory of nuclear structure and nuclear reactions; intermediate-energy nuclear theory; pion physics. Prerequisite: Phys. 562.

557. **ELECTRICITY AND MAGNETISM (3)** Electro- and magnetostatics, Maxwell's equations, boundary value problems, electric and magnetic properties of material media.

558. **ADVANCED ELECTRICITY AND MAGNETISM (3)** Energy and momentum in the field, radiation theory, classical relativistic electron theory. Prerequisite: Phys. 557.

559. **GRADUATE LABORATORY (1)** Introduction to techniques and instrumentation used in modern physics laboratories. Includes experience in planning experiments and working in research laboratories.

561-562. **QUANTUM MECHANICS (3 each)** The basic theory of wave and matrix mechanics, approximation methods, applications. Prerequisite: Phys. 530.

563-564. **ADVANCED QUANTUM MECHANICS (3 each)** Relativistic wave equations, quantum field theory, other advanced quantum theoretical topics. Prerequisite: Phys. 562.

571. **ATOMIC PHYSICS (3)** Experimental basis of modern physics; atomic spectra and structure, nuclear phenomena.

572. **MOLECULAR PHYSICS (3)** Electronic and nuclear motions in molecules, molecular spectra and structure. Prerequisite: Phys. 571.

596. **INDIVIDUAL STUDIES (1-9)**

597. **SPECIAL TOPICS (1-9)** (e.g., surface physics, tunneling theory, field-ion microscopy, liquid helium, superconductivity, vacuum physics, ion optics, nonlinear optics, many-body theory.)

## PHYSIOLOGY (PHSIO)

ELSWORTH R. BUSKIRK, *Chairman of the Committee on Physiology*  
119 Noll Laboratory  
814-865-3453

### Degrees Conferred: Ph.D., M.S.

#### Senior Members of the Graduate Faculty

Adam Anthony, Ph.D. (Chicago) *Professor of Zoology*  
Craig R. Baumrucker, Ph.D. (Purdue) *Associate Professor of Animal Nutrition-Physiology*  
Leslie P. Bullock, D.V.M. (California, Davis) *Associate Professor of Comparative Medicine*  
Elsworth R. Buskirk, Ph.D. (Minnesota) *Professor of Applied Physiology*  
Robert J. Eberhart, Ph.D. (Penn State) *Professor of Veterinary Science*  
Edwin V. Gaffney, Ph.D. (Catholic) *Associate Professor of Microbiology and Cell Biology*  
Michael H. Green, Ph.D. (California, Berkeley) *Assistant Professor of Nutrition Science*  
Timothy S. Harrison, M.D. (Johns Hopkins) *Professor of Surgery and Physiology*  
James L. Hodgson, Ph.D. (Minnesota) *Associate Professor of Physical Education*  
Theodore M. Hollis, Ph.D. (Ohio State) *Associate Professor of Biology*  
Leonard S. Jefferson, Jr., Ph.D. (Vanderbilt) *Professor of Physiology*  
Eliezer Kamon, Ph.D. (Hebrew) *Professor of Applied Physiology and Ergonomics*  
Kathryn F. LaNoue, Ph.D. (Yale) *Professor of Physiology*  
Roland M. Leach, Jr., Ph.D. (Cornell) *Professor of Poultry Science*  
Richard L. McCarl, Ph.D. (Penn State) *Professor of Biochemistry*  
Jose de la Vega Mendez, Ph.D. (Minnesota) *Professor of Health and Applied Physiology*  
Howard E. Morgan, M.D. (Johns Hopkins) *Evan Pugh Professor of Physiology*  
Glenn E. Mortimore, M.D. (Oregon) *Professor of Physiology*  
Ralph O. Mumma, Ph.D. (Penn State) *Professor of Chemical Pesticides*  
James R. Neely, Ph.D. (Vanderbilt) *Professor of Physiology*  
Anthony E. Pegg, Ph.D. (Cambridge) *Professor of Physiology*  
Donald E. Rannels, Jr., Ph.D. (Penn State) *Associate Professor of Physiology*  
Richard C. Rose, Ph.D. (Michigan State) *Professor of Physiology and Surgery*  
Richard W. Scholz, Ph.D. (Purdue) *Professor of Veterinary Science*  
Phillip L. Senger, Ph.D. (Virginia Polytechnic) *Associate Professor of Dairy Physiology*  
Paul J. Wangsness, Ph.D. (Iowa State) *Associate Professor of Animal Nutrition*  
Carol F. Whitfield, Ph.D. (George Washington) *Assistant Professor of Physiology*  
Robert F. Zelis, M.D. (Chicago) *Professor of Medicine and Physiology*

#### Associate Members of the Graduate Faculty

Terry D. Etherton, Ph.D. (Minnesota) *Assistant Professor of Animal Nutrition*  
Stephen F. Flaim, Ph.D. (California, Davis) *Assistant Professor of Medicine and Physiology*  
Steven R. Goodman, Ph.D. (St. Louis) *Assistant Professor of Physiology*  
Christine M. Gregg, Ph.D. (Michigan) *Assistant Professor of Biology*  
Daniel R. Hagen, Ph.D. (Illinois) *Assistant Professor of Animal Science*  
Richard A. Hawkins, Ph.D. (Harvard) *Professor of Anaesthesia and Physiology*  
Magdi M. Mashaly, Ph.D. (Wisconsin) *Assistant Professor of Poultry Science*  
Robert B. Mitchell, Ph.D. (Penn State) *Associate Professor of Biology*  
William H. Neff, Ph.D. (Penn State) *Associate Professor of Zoology*  
W. Channing Nicholas, M.D. (Pennsylvania) *Associate Professor of Applied Physiology*  
Anton C. Schoolwerth, M.D. (Harvard) *Associate Professor of Medicine and Physiology*  
Jane A. Idell-Wenger, Ph.D. (Minnesota) *Assistant Professor of Medicine and Physiology*  
Robert F. Wideman, Jr., Ph.D. (Connecticut) *Assistant Professor of Poultry Science*

This is an intercollege program designed to enable students to obtain an integrated series of courses encompassing both the fundamentals of physiology and advanced training in a specialized area. Courses can be taken either at The Milton S. Hershey Medical Center or at University Park.

Graduate instruction in physiology is under the direction of a program committee composed of graduate faculty representing several departments or groups at University Park actively participating in the physiology program — including the areas of animal industry, animal nutrition, biochemistry, bioengineering, biology, dairy science, microbiology, nutrition, physical education, poultry science, veterinary science, and zoology — as well as the Department of Physiology at The Hershey Medical Center. The instructional staff is composed of faculty in those departments offering graduate courses in various areas of specialization in physiology. The program, including courses, laboratory experience, and original research, is designed for completion in three to four academic years.



### Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.

Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

### Degree Requirements

Deficiencies in chemistry, mathematics (through calculus), or biological science must be made up early in the student's graduate program. All candidates (master's and doctoral) must complete a general basic laboratory course in physiology (combined cellular, mammalian, and comparative) before choosing an area of specialization. Possible areas of specialization are cardiovascular and respiratory physiology; cellular and subcellular physiology; comparative physiology; environmental physiology; exercise physiology; physiology of nutrition and metabolism; neurophysiology; renal physiology; and reproductive physiology. The graduate committee for majors shall be appropriately represented by members of the physiology program committee and those of the area of specialization who shall have the responsibility and jurisdiction for determining the course program and research acceptable in satisfying degree requirements. The nonthesis option is available for the M.S. degree.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by one of several options including intermediate knowledge of one foreign language.

### Other Relevant Information

The following courses, among others, are available for physiology majors, and their descriptions may be found under the offerings of several departments: Agro. 512, 545; An.Sc. 431, 510, 514; A.Ntr. 401, 501, 503; Bioch. 401, 402, 417, 437, 438; Bioe. 402, 504; Biol. 409, 428, 429, 437, 472, 473, 479, 538, 539, 550; Cmp.Sc. 410; Ed.Psy. 400, 406, 506, 507; E.E. 569; Fd.Sc. 521; Hl.Ed. 511, 513; Micrb. 400, 401, 414, 478, 503; Nuc.E. 415, 420; Nutr. 452, 457, 458, 459, 530, 552, 557; Ph.Ed. 456, 457, 480, 565, 567, 568, 577, 580, 586, 587, 588; Phys. 400, 402, 420; Psy. 402, 455; Stat. 451, 460, 461, 462, 464; 501, 502; V.Sc. 405, 418, 420, 525, 528, 535, 550.

The following courses in anatomy and biochemistry are offered at The Milton S. Hershey Medical Center: Anat. 501, 502, 505, 510, 512, 513, 515, 530, 535, 542, 543, 545, 550, 590, 596, 597; B.Chem. 502, 503, 505, 513, 523, 551, 553, 590, 596, 597. Descriptions of these courses may be found under the designated program.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

NATIONAL INSTITUTE OF AGING TRAINEESHIPS — Available to doctoral students in selected graduate programs for research training in adult development and aging; stipend varies. Details available from the Gerontology Center, S-211 Henderson Human Development Building.

MRS. A. ROBERT NOLL GRADUATE FELLOWSHIP IN APPLIED PHYSIOLOGY — For graduate research in applied physiology, especially in environmental or exercise physiology; stipend variable.

### PHYSIOLOGY (PHSIO)

\*520. MEDICAL PHYSIOLOGY (2) Cellular physiology including membrane, permeability, bioelectric potentials, muscular contractions, secretion; metabolic physiology, including control of metabolism by hormones.

\*521. MEDICAL PHYSIOLOGY (3) Organ physiology; examination of respiratory, renal, gastrointestinal, and cardiovascular physiology.

\*This course is offered at The Milton S. Hershey Medical Center.

## PHYSIOLOGY

\*522. **PHYSIOLOGY LABORATORY (1)** Practical exercises in the areas of neuromuscular physiology, metabolism, and endocrinology. Prerequisites: one year of biology, two years of chemistry, and one year of physics. Concurrent: Phsio. 520.

\*523. **PHYSIOLOGY LABORATORY (1)** Practical exercises in the areas of cardiovascular, respiratory, renal, and gastrointestinal physiology. Prerequisite: Phsio. 520. Concurrent: Phsio. 521.

\*525. **GENERAL PHYSIOLOGY (2)** Cellular processes of accumulation membrane transport, bioelectric potentials, contraction, and secretion in erythrocytes, nerves, sensory receptors, muscles, glands, excretory organs.

\*530. **METABOLIC AND ENDOCRINE PHYSIOLOGY (3)** Regulation of carbohydrates, fatty acid, and protein metabolism; regulation of hormone secretion; effects of hormones on water and cell metabolism.

\*532. **REPRODUCTIVE PHYSIOLOGY (3)** Physiology of mammalian reproductive systems, including synthesis, secretion, and mechanism of action of the steroids and polypeptide hormones involved. Prerequisites: Phsio. 520, 521.

\*534. **HEART AND SKELETAL MUSCLE (2)** Discussion of structure, chemistry, and physiology of heart and skeletal muscle. Prerequisites: Phsio. 520, 521.

\*536. **GASTROINTESTINAL PHYSIOLOGY (2)** Mechanisms of absorption and secretion by stomach, intestine, pancreas, and gallbladder. Neural and hormonal regulation, bioelectric potentials, pathophysiology. Prerequisite: Phsio. 521.

567. (Ph.Ed. 567) **ADVANCED EXERCISE PHYSIOLOGY (3)** Physiological changes during exercise, with emphasis on the effects of physical conditioning and training. Prerequisites: Biol. 472, Ph.Ed. 480.

568. (Ph.Ed. 568) **ERGONOMICS (3)** Anthropometric, biomechanical, and physiological characteristics of working man and their importance in the man-machine-environment complex. Prerequisites: Biol. 472, Ph.Ed. 480; I.E. 408 recommended for engineering students.

571. (Biol. 571) **ANIMAL PHYSIOLOGY (2)** Mammalian cardiovascular system; mammalian neurophysiology; excitable tissue, sensory systems, motor systems, and autonomic system. Prerequisite: Biol. 472.

572. (Biol. 572) **ANIMAL PHYSIOLOGY (2)** Mechanisms involved in the activity and control of gastrointestinal function, respiration, and renal regulation of blood and body fluids. Prerequisite: Biol. 472.

573. (Biol. 573) **ANIMAL PHYSIOLOGY (2)** Hypothalamic-hypophyseal relationships. Reproductive cycle regulation, endocrine control of fluid balance, body temperature, energy homeostasis, and metabolism of protein and minerals. Prerequisite: Biol. 472.

577. (Ph.Ed. 577) **APPLIED CARDIOVASCULAR PHYSIOLOGY (2)** In-depth study of cardiovascular system physiology. Prerequisite: 4 credits in physiology at the 400 or 500 level.

580. (Ph.Ed. 580) **ANALYSIS OF BODY COMPOSITION (2)** Study of the methods employed in the analysis of body composition. Prerequisite: Biol. 472 or 3 credits in physiology at the 400 or 500 level.

585. (Ph.Ed. 585) **APPLIED PHYSIOLOGY: THERMAL (3)** Physiological mechanisms activated by exposure to environmental temperature. Prerequisite: Ph.Ed. 480 or 3 credits in physiology at the 400 or 500 level.

586. (Ph.Ed. 586) **RESEARCH METHODS IN APPLIED PHYSIOLOGY (3)** Historical and current procedures for evaluation of cardio-pulmonary function, metabolism, and thermal balance in man; lecture, demonstration, and student laboratory. Prerequisite: 3 credits in physiology at the 400 or 500 level.

587. (Ph.Ed. 587) **APPLIED PHYSIOLOGY: AMBIENT PRESSURE (3)** Physiological mechanisms activated by exposure to environmental pressure. Prerequisite: Ph.Ed. 480 or 3 credits in physiology at the 400 or 500 level.

†590. **COLLOQUIUM (1-3)**

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\*This course is offered at The Milton S. Hershey Medical Center.

†This course is also offered at The Milton S. Hershey Medical Center.



†596. INDIVIDUAL STUDIES (1-9)

†597. SPECIAL TOPICS (1-9)

## PLANT PATHOLOGY (PPATH)

JOHN M. SKELLY, *Head of the Department*  
211 Buckhout Laboratory  
814-865-7448

**Degrees Conferred:** Ph.D., M.S., M.Agr.

### Senior Members of the Graduate Faculty

John E. Ayers, Ph.D. (Penn State) *Professor of Plant Pathology*  
James R. Bloom, Ph.D. (Wisconsin) *Professor of Plant Pathology*  
John S. Boyle, Ph.D. (Wisconsin) *Professor Emeritus of Plant Pathology*  
Herbert Cole, Jr., Ph.D. (Penn State) *Professor of Plant Pathology*  
Donald D. Davis, Ph.D. (Penn State) *Professor of Plant Pathology*  
Charles H. Kingsolver, Ph.D. (Iowa State) *Adjunct Professor of Plant Pathology*  
Kenneth T. Leath, Ph.D. (Minnesota) *Adjunct Professor of Plant Pathology*  
Felix L. Lukezic, Ph.D. (California) *Professor of Plant Pathology*  
David R. MacKenzie, Ph.D. (Penn State) *Professor of Plant Pathology*  
William Merrill, Ph.D. (Minnesota) *Professor of Plant Pathology*  
Paul E. Nelson, Ph.D. (California) *Professor of Plant Pathology*  
Richard R. Nelson, Ph.D. (Minnesota) *Evan Pugh Professor of Plant Pathology*  
John W. Oswald, Ph.D. (California) *Professor of Plant Pathology*  
Eva J. Pell, Ph.D. (Rutgers) *Associate Professor of Plant Pathology*  
Richard D. Schein, Ph.D. (California) *Professor of Plant Pathology*  
Lee C. Schisler, Ph.D. (Penn State) *Professor of Plant Pathology*  
Robert T. Sherwood, Ph.D. (Wisconsin) *Adjunct Professor of Plant Pathology*  
John M. Skelly, Ph.D. (Penn State) *Professor of Plant Pathology*  
Samuel H. Smith, Ph.D. (California) *Professor of Plant Pathology*  
T. A. Toussoun, Ph.D. (California) *Professor of Plant Pathology*  
Paul J. Wuest, Ph.D. (Penn State) *Professor of Plant Pathology*

### Associate Members of the Graduate Faculty

James A. Frank, Ph.D. (Illinois) *Adjunct Associate Professor of Plant Pathology*  
Kenneth D. Hickey, Ph.D. (Penn State) *Professor of Plant Pathology*  
Alan A. MacNab, Ph.D. (Cornell) *Professor of Plant Pathology Extension*  
William J. McCarthy, Ph.D. (New York) *Assistant Professor of Plant Pathology*  
Stanley P. Pennypacker, Ph.D. (Penn State) *Associate Professor of Plant Pathology*  
C. Peter Romaine, Ph.D. (Cornell) *Assistant Professor of Plant Pathology*  
Daniel J. Royse, Ph.D. (Illinois) *Assistant Professor of Plant Pathology*  
Richard F. Stouffer, Ph.D. (Cornell) *Professor of Plant Pathology*

Plant pathology is the study of disease in plants and concerns the dynamic interaction between the plant, the causal agent (bacteria, fungi, viruses, nematodes, etc.), and their environments. A student prepares for a professional career in research, teaching, extension, or industry through advanced studies of the principles of plant infection, the physiology of disease in plants, the ecology of root diseases, the nature and inheritance of disease resistance in plants, epidemiology, ecology and physiology of air pollution injury to plants, or plant disease control by biological or chemical means. A student also may specialize in the nature and control of the diseases of forest trees, agronomic or horticultural crops, and commercial mushrooms. Advanced studies in applied mycology, related to the production of the commercial mushroom, also may be taken. Modern, well-equipped laboratories, controlled environment facilities and greenhouses, and well-developed field research areas are available for graduate study.

### Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for

†This course is also offered at The Milton S. Hershey Medical Center.

graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.

Students scoring in the 50 percentile or above on each section of the Graduate Record Examination will be given preference. The best-qualified applicants will be accepted up to the number of spaces and advisers that are available for new students. Students with a 2.80 junior-senior average and with appropriate course backgrounds will be considered for admission. Exceptions to the minimum 2.80 grade-point average may be made for students with special backgrounds, abilities, and interests.

For admission a student must present 42 credits in the natural sciences, including a minimum of 15 credits in the plant sciences and a minimum of 15 credits in mathematics, chemistry, or physics. Students with a strong background in agronomy, biochemistry, biophysics, botany, forestry, genetics, horticulture, or microbiology are usually well prepared for advanced study in plant pathology.

## Degree Requirements

Specific requirements for the M.S. and Ph.D. programs are available on request.

The Master of Agriculture degree is offered to provide professional training in plant pathology with more of a crop orientation than is available under the M.S. program. In addition to the courses required for an M.S. degree, the Master of Agriculture degree requires further study in the areas of entomology and crop sciences. A thesis substitute, such as an internship report, or an adaptive or demonstrative activity whereby known technology or procedures are applied, is acceptable.

Competency in a foreign language is not required for the Ph.D. degree. However, depending upon the nature of the thesis research and with the advice and consent of the doctoral advisory committee, competency in a foreign language may be judged to be an essential part of the doctoral studies of certain students.

## Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## PLANT PATHOLOGY (PPATH)

401. THEORY AND CONCEPTS OF PLANT PATHOLOGY (3) *Merrill and Staff*
402. DISEASES OF ECONOMIC PLANTS (2 per semester, maximum of 8) *Merrill and Staff*
403. INTRODUCTION TO EPIDEMIOLOGY AND PLANT DISEASE MANAGEMENT (3) *Schein*
404. LABORATORY TECHNIQUES TO ELUCIDATE PRINCIPLES OF PLANT PATHOLOGY (5) *Wuest*
420. PLANT PATHOGENIC BACTERIA (3) *Lukezic*
422. INTRODUCTION TO PLANT VIROLOGY (3) *Romaine*
424. ENVIRONMENTAL PATHOLOGY (3) *Davis*
426. PLANT PATHOGENIC FUNGI (3) *Toussoun*
429. PHYTONEMATOLOGY (3) *Bloom*
496. INDEPENDENT STUDIES (1-18)
497. SPECIAL TOPICS (1-9)
  
502. PLANT DISEASE DIAGNOSIS (3) Field and laboratory techniques used in diagnosing plant diseases caused by various types of pathogens with emphasis on fungi. Prerequisites: P.Path. 401, 404, 426. *Davis*
535. PRINCIPLES OF PLANT EPIDEMIOLOGY (3) Analytical methodology useful in describing pest epidemics on crop populations and the application of this information for pest control. Prerequisites: Agro. 512, P.Path. 401. *MacKenzie*
540. PLANT DISEASE CONTROL (3) Principles of plant disease control, including theoretical considerations involved in control by chemical and nonchemical means. *Cole*
541. PHYSIOLOGY OF PLANT DISEASE (3) Physiology of the diseased plant, including the host response to the pathogen and parasitic properties of the pathogen. *Lukezic*
542. EPIDEMIOLOGY OF PLANT DISEASES (3) Disease development in populations of plants, with emphasis on the impact of environment and control practices on rate of development. Prerequisites: P.Path. 401; Math. 111 or 141 or 3 credits in statistics. *Pennypacker*



543. **PATHOGEN VARIATION AND HOST RESISTANCE (3)** Mechanisms and implications of genetic variation in plant pathogens related to breeding for disease resistance in plants by genetic means. Prerequisite: P.Path. 401 or Agro. 411 or Hort. 407. *Ayers*
544. **PATHOLOGICAL PLANT ANATOMY (3)** Structural manifestations occurring in diseased plants. Prerequisite: Biol. 407. *P. E. Nelson*
560. **PRINCIPLES OF PLANT PATHOLOGY (3)** Open-ended discussions of concepts of plant pathology, with emphasis on their interrelationships and their significance to the science. *R. R. Nelson*
590. **COLLOQUIUM (1-3)**
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**
602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)**

## POLITICAL SCIENCE (PL SC)

JOHN D. MARTZ, *Head of the Department*  
112 Burrowes Building  
814-865-7515

**Degrees Conferred:** Ph.D., M.A.

### Senior Members of the Graduate Faculty

Henry S. Albinski, Ph.D. (Minnesota) *Professor of Political Science*  
Vernon V. Asaturian, Ph.D. (California, Los Angeles) *Evan Pugh Professor of Political Science*  
J. Cudd Brown, Ph.D. (Oregon) *Professor of Political Science*  
Parris H. Chang, Ph.D. (Columbia) *Professor of Political Science*  
James Eisenstein, Ph.D. (Yale) *Professor of Political Science*  
Robert S. Friedman, Ph.D. (Illinois) *Professor of Political Science*  
Trond Gilberg, Ph.D. (Wisconsin) *Professor of Political Science*  
Robert E. Harkavy, Ph.D. (Yale) *Associate Professor of Political Science*  
Edward Keynes, Ph.D. (Wisconsin) *Professor of Political Science*  
Michael R. King, Ph.D. (Oregon) *Associate Professor of Political Science*  
Stanley A. Kochanek, Ph.D. (Pennsylvania) *Professor of Political Science*  
John D. Martz III, Ph.D. (North Carolina) *Professor of Political Science*  
David J. Myers, Ph.D. (California, Los Angeles) *Associate Professor of Political Science*  
Robert E. O'Connor, Ph.D. (North Carolina) *Associate Professor of Political Science*  
Larry D. Spence, Ph.D. (California, Berkeley) *Associate Professor of Political Science*

### Associate Members of the Graduate Faculty

Bruce A. Murphy, Ph.D. (Virginia) *Assistant Professor of Political Science*  
Martin E. Orland, Ph.D. (Syracuse) *Assistant Professor of Political Science*  
Wendy J. Sarvasy, Ph.D. (California, Los Angeles) *Assistant Professor of Political Science*

The purpose of the graduate program in Political Science is to train professional political scientists who intend to pursue careers in research, teaching, and public service. The department offers programs leading to the M.A. and Ph.D. degrees. The programs are designed to enable students to acquire both methodological sophistication and substantive knowledge in a variety of fields.

The graduate program in Political Science encourages the study of a variety of substantive concerns, methodological approaches, and research skills. Among the department's special areas of strength are the legislative and judicial processes; political parties and interest groups; administrative systems, urban politics; the politics and foreign policies of the Soviet Union, China, Latin America, South Asia, the British Commonwealth, and Eastern and Western Europe; international relations, law, and organizations; and a number of public policy areas. The department has a faculty of eighteen full-time members.

### Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the

*APPLICATION AND ADMISSION* section of the *Graduate Bulletin*.) Requirements listed below are in addition to general Graduate School requirements stated in the *GENERAL INFORMATION* section of the *Graduate Bulletin*.

Admission for either the M.A. or Ph.D. degree program must include transcripts, Graduate Record Examination scores (verbal and quantitative), a statement indicating career plans and proposed emphasis in political science, and at least two letters of recommendation from academic personnel.

Students with a 3.00 junior-senior average and appropriate course backgrounds, including at least the equivalent of 12 credits in political science, will be considered for admission.

Students can be admitted to the master's program or, after passing a Ph.D. candidacy exam, can be admitted to the Ph.D. program with a master's degree.

### **Master's Degree Requirements**

For the M.A., 30 to 33 credits in course work (depending on previous methodological training) and an M.A. thesis or essay are required. There is no language requirement for the degree. Course work includes a methodological core of 6 to 9 credits (Pl.Sc. 409, 410, and 509, or their equivalents); 12 credits in a primary field (including core course in field); 6 credits in a secondary field; and 6 credits for the M.A. thesis, or 6 elective credits if the M.A. essay option is selected. Master's candidates are required to pass an M.A. comprehensive examination.

### **Doctoral Degree Requirements**

The communication and foreign language requirement for the Ph.D. may be satisfied by competence in approved skills selected from among foreign languages, statistics, or mathematics and computer science.

Ph.D. students are required to take a core seminar in each of the five fields offered in the department: (1) American government and politics; (2) comparative politics; (3) international politics, organization, and law; (4) political theory and methodology; and (5) public administration.

In addition, each Ph.D. candidate is required to complete Pl.Sc. 509 (Scope and Methods) and Pl.Sc. 510 (Advanced Quantitative Political Analysis).

All students for the Ph.D. degree must present three fields for the purposes of comprehensive examinations. Two fields must be selected from the five above. The third field can be selected either from outside the department or from within the department.

### **Other Relevant Information**

The Department of Political Science has a successful faculty and student exchange program with the University of Kiel, West Germany.

The department offers a vigorous graduate program that provides students a number of opportunities to interact informally with faculty and other graduate students. Both faculty and graduate students make extensive use of the Liberal Arts Data Lab and of the department's own remote job entry terminal.

### **Student Aids**

Graduate assistantships available to students in this program and other forms of student aid are described in the *STUDENT AIDS* section of the *Graduate Bulletin*.

## **POLITICAL SCIENCE (PL SC)**

- 403. THE LEGISLATIVE PROCESS (3) *Keynes and King*
- 405. THE AMERICAN PRESIDENCY (3) *Murphy*
- 409. QUANTITATIVE POLITICAL ANALYSIS (3) *King*
- 410. INTRODUCTION TO POLITICAL RESEARCH (3) *King and O'Connor*
- 412. INTERNATIONAL ECONOMIC POLITICS (3) *Harkavy*
- 413. GOVERNMENT AND POLITICS OF THE SOVIET UNION (3) *Aspaturian and Gilberg*
- 414. FOREIGN POLICY OF THE SOVIET UNION (3) *Aspaturian*
- 415. INTERNATIONAL ORGANIZATION: POLITICAL AND SECURITY FUNCTIONS (3-6) *Aspaturian, Brown, and Harkavy*
- 416. INTERNATIONAL LAW (3) *Brown*
- 417. AMERICAN LOCAL GOVERNMENT AND ADMINISTRATION (3) *Friedman, O'Connor, and Orland*
- 418. INTERNATIONAL RELATIONS THEORY (3)
- 419. BUREAUCRACY AND PUBLIC POLICY (3) *Friedman and Spence*
- 420. POLICY MAKING AND EVALUATION (3) *Orland*
- 422. COMPARATIVE URBAN POLITICS (3) *Gilberg and Myers*



425. GOVERNMENT AND POLITICS OF THE AMERICAN STATES (3) *Friedman and O'Connor*
427. POLITICAL OPINION (3) *O'Connor*
430. SELECTED WORKS IN THE HISTORY OF POLITICAL THEORY (3) *Sarvasy and Spence*
431. ANCIENT, MEDIEVAL, AND RENAISSANCE POLITICAL THEORIES (4) *Sarvasy and Spence*
432. MODERN AND CONTEMPORARY POLITICAL THEORIES (4) *Sarvasy and Spence*
435. FOUNDATIONS OF AMERICAN POLITICAL THEORY (3) *Sarvasy and Spence*
436. STUDIES IN NINETEENTH- AND TWENTIETH-CENTURY AMERICAN POLITICAL THOUGHT (3) *Sarvasy and Spence*
438. NATIONAL SECURITY POLICIES (3) *Brown and Myers*
442. AMERICAN FOREIGN POLICY (3) *Brown and Harkavy*
443. AMERICAN SECURITY PROBLEMS (3) *Brown, Chang, and Harkavy*
444. GOVERNMENT AND THE ECONOMY (3) *Friedman and Orland*
446. THE AMERICAN LEGAL PROCESS (3) *Eisenstein, Keynes, and Murphy*
447. CONSTITUTIONAL LAW: THE FEDERAL SYSTEM (3) *Keynes and Murphy*
448. CONSTITUTIONAL LAW: DEFENDANT'S RIGHTS (3) *Keynes and Murphy*
449. CONSTITUTIONAL LAW: INDIVIDUAL AND MINORITY RIGHTS (3) *Keynes and Murphy*
450. CANADIAN AND AUSTRALIAN POLITICS AND FOREIGN POLICIES (3) *Albinski*
451. COMPARATIVE POLITICAL ANALYSIS (3) *Albinski and Martz*
452. GOVERNMENTS AND POLITICS OF EASTERN EUROPE (3) *Gilberg*
453. POLITICAL PROCESSES IN UNDERDEVELOPED SYSTEMS (3-6) *Chang, Kochanek, and Myers*
454. GOVERNMENT AND POLITICS OF AFRICA (3) *Brown*
455. GOVERNMENTS AND POLITICS OF WESTERN EUROPE (3) *Gilberg*
456. POLITICS AND INSTITUTIONS OF LATIN-AMERICAN NATIONS (3) *Martz and Myers*
457. INTERNATIONAL POLITICS OF LATIN AMERICA (3-6) *Martz and Myers*
458. GOVERNMENT AND POLITICS OF EAST ASIA (3-6) *Chang*
459. GOVERNMENT, POLITICS, AND INTERNATIONAL RELATIONS OF SOUTH ASIA (3) *Kochanek*
462. MARXIST AND SOCIALIST POLITICAL THEORY (3) *Sarvasy and Spence*
466. COMPARATIVE FOREIGN POLICIES OF WESTERN EUROPE (3) *Brown*
467. INTERNATIONAL RELATIONS OF THE MIDDLE EAST (3) *Harkavy*
468. INTERNATIONAL RELATIONS OF EAST ASIA (3) *Chang*
495. POLITICAL SCIENCE INTERNSHIP (1-9)
496. INDEPENDENT STUDIES (1-18)
497. SPECIAL TOPICS (1-9)
499. FOREIGN STUDY — GOVERNMENT (2-6)
  
500. POLITICAL POWER (3-6) Subject announced prior to semester offered.
507. AMERICAN GOVERNMENT PROSEMINAR (3) Review of basic literature in major fields of American government: public opinion parties, voting, interest groups, presidency, congress, judiciary, etc. *Eisenstein*
509. SCOPE AND METHOD OF POLITICAL SCIENCE (3-6) *King, Martz, and O'Connor*
510. ADVANCED QUANTITATIVE POLITICAL ANALYSIS (3) Analysis of selected issues in quantitative political analysis; introduction to advanced multivariate analysis techniques. Prerequisite: Pl.Sc. 409. *King*
512. COMPARATIVE POLITICAL SYSTEMS (3-9) *Albinski, Chang, Kochanek, and Myers*
513. SEMINAR IN COMPARATIVE POLITICAL PARTIES (3-6) Nature, function, organization, and leadership of parties; party systems, political culture, voting, and the institutional framework. *Albinski and King*
515. INTERNATIONAL POLITICS (3-6) *Harkavy*
516. SEMINAR IN INTERNATIONAL RELATIONS THEORY AND METHODOLOGY (3) A detailed analysis of major traditional and contemporary theory-building efforts and contemporary research techniques and orientations in international relations. *Brown and Harkavy*
517. INTERNATIONAL ORGANIZATION (3-6) *Aspaturian*
521. MODERN DEMOCRATIC POLITICAL THEORY (3-6) *Sarvasy and Spence*
522. SEMINAR IN THE HISTORY OF POLITICAL THEORY (3) Analysis of selected political theorists or historical traditions of political thought. *Sarvasy and Spence*

523. SOVIET POLITICAL BEHAVIOR (3) Forces which shape rivalries for power; decision-making processes; areas of agreement and dissent. *Aspaturian and Gilberg*
524. FOREIGN POLICIES OF THE SOVIET BLOC (3-6) Major policies, the decision-making process, and the impact upon component members and external rivals for power. *Aspaturian and Gilberg*
525. COMPARATIVE AMERICAN STATE AND LOCAL POLITICS (3-6) Literature and research in comparative state and local political systems in the United States. *Friedman and O'Connor*
526. MASS POLITICS AND PUBLIC OPINION (3) Literature and research in mass politics and public opinion in the United States.
527. POLITICS AND LEGISLATIVE BEHAVIOR (3-6) Social factors which shape and determine the attitudes and decisions of American legislators and legislative bodies. *Keynes and King*
529. INTERGOVERNMENTAL RELATIONS (3) Intergovernmental features of the United States system compared with those of other nations. *Friedman and Keynes*
530. PUBLIC LAW (3-6) The nature of law and its role in modern society. *Eisenstein, Keynes, and Murphy*
532. NORMATIVE AND ANALYTICAL POLITICAL THEORY (3) Consideration of problems in contemporary theory construction. *King and Spence*
546. JUDICIAL PROCESS (3) Court functions in the political process; sources and limits of judicial power; perceptions of the judicial role; judicial decision making. Prerequisites: 12 credits in political science. *Eisenstein and Keynes*
554. AFRICAN POLITICAL SYSTEMS (3-6) Impact of European colonialism; cultural and anthropological factors in political development; modernization and analysis of selected problems in contemporary Africa. Prerequisite: 3 credits of comparative government or international relations at the 400 level. *Brown*
572. (Pub.A. 572) INTERNATIONAL DEVELOPMENT ADMINISTRATION (3-6) The examination of bilateral and multilateral development assistance programs; planning implementation; and evaluation of development programs in LDCs. *Brown and LaPorte*
573. (Pub.A. 573) COMPARATIVE PUBLIC ADMINISTRATION (3-6) Administrative systems of selected nations on a functional basis; relationship between culture, economic and social systems, and public administration. *LaPorte and Myers*
574. (Pub.A. 574) SEMINAR IN THE ADMINISTRATION OF UNITED STATES FOREIGN AFFAIRS (3) Effect of cross-cultural operations on the normal process of administration of United States foreign affairs. *Brown and LaPorte*
586. THEORY OF BUREAUCRATIC AND ADMINISTRATIVE POLITICS (3-6) The role of the executive in government and politics; theories of administrative organization, organization behavior, and decision-making processes. *Friedman*
591. (Pub.A. 591) NATIONAL SECURITY ADMINISTRATION (3) National security system defense organization, decision making, and administration supply management; contract administration and procurement impact of defense expenditures.
594. READINGS IN POLITICAL SCIENCE (1-6) Directed readings in selected areas of the discipline.
595. RESEARCH IN POLITICAL SCIENCE (1-6) Directed research in selected areas of the discipline.
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)



## POLYMER SCIENCE (PLMSC)

MICHAEL M. COLEMAN, *In Charge of Graduate Program in Polymer Science*  
325 Steidle Building  
814-865-1288

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Michael M. Coleman, Ph.D. (Case Western Reserve) *Professor of Polymer Science*  
Ian R. Harrison, Ph.D. (Case Western Reserve) *Professor of Polymer Science*  
Donald E. Kline, Ph.D. (Penn State) *Professor of Materials Science*

### Associate Members of the Graduate Faculty

Bernard Gordon III, Ph.D. (Arizona) *Assistant Professor of Polymer Science*  
Paul C. Painter, Ph.D. (Case Western Reserve) *Associate Professor of Polymer Science*  
James P. Runt, Ph.D. (Penn State) *Assistant Professor of Polymer Science.*

The Polymer Science degree program is one of four areas in which a graduate student in the Department of Materials Science and Engineering may receive an advanced degree.

Polymer science is a multidisciplinary subject primarily concerned with the study of macromolecules (chain-like molecules of very high molecular weight). Polymeric materials are pervasive in today's technological society and find numerous applications in such diverse fields as plastics, elastomers (rubber), adhesives, surface coatings (paints), textiles, paper, packaging, and composites. Research facilities are available for studies involving the synthesis, chemical and physical characterization, and mechanical properties of polymeric materials. Special instrumentation exists for research in the areas of vibrational spectroscopy, thermal analysis, X-ray, size-exclusion chromatography, and mechanical testing.

Graduates with advanced degrees in Polymer Science are prepared for research and development careers in numerous academic, industrial, and government organizations involved with polymeric materials.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in the program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Applications will be accepted from those having degrees in the basic or applied physical sciences or in engineering disciplines. Students with a 3.00 junior-senior average normally will be considered for admission. Exceptions may be made for students with special abilities, interests, or backgrounds, such as extensive industrial experience in polymer science.

A student entering the program with a B.S. degree normally will be expected to complete an M.S. thesis before continuing to the Ph.D. degree.

### Master's Degree Requirements

There are no additional credit requirements beyond the Graduate School minimum of 30 credits, although most graduate students in the program will exceed this minimum. A nonthesis option for the M.S. degree is available in which a master's paper is required rather than a thesis. However, a student taking this option cannot continue toward a Ph.D. degree in the program. Competency in a foreign language is not required for the M.S. degree, but candidates are expected to demonstrate high proficiency in both written and spoken English.

Course work required for the M.S. degree will depend on the individual candidate's specific background and will be decided upon in consultation with the faculty members on the student's study panel. In general, the student will be required to take those courses deemed necessary to ensure a fundamental understanding of polymer science.

A candidacy examination will be administered during the second and third semester for students enrolled in the M.S. thesis degree program. A typewritten technical paper of fifteen to thirty pages in length, the subject of which is decided upon by the student's study panel, must be submitted to the faculty members of the study panel at least one week prior to an oral examination. A decision concerning Ph.D. candidacy is made upon completion of this examination.

### Doctoral Degree Requirements

Competency in a foreign language is not required for the Ph.D. degree, but candidates will be expected to demonstrate high proficiency in both written and spoken English. In addition, candidates will be expected to become familiar with the basics of a computer language.

There are no specific course work requirements for the Ph.D. degree, but candidates will be expected to have a thorough understanding of the basics of polymer science.

An oral comprehensive examination will be administered by the student's doctoral committee upon completion of the majority of the candidate's formal course work. The candidate will submit a brief written summary of his or her research topic to the members of the doctoral committee at least three days prior to the examination. At the oral examination, the candidate will present a seminar on his or her research topic and will be questioned by the doctoral committee on this topic and any other aspect in the overall field of polymer science. A decision concerning the comprehensive examination will then be made by the faculty members on the doctoral committee.

### Other Relevant Information

The Polymer Science faculty consider that a good professional relationship between the faculty and graduate students is essential for graduate studies. Accordingly, graduate students are encouraged to interact with the faculty, and the faculty maintains an "open-door" policy.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

DOW CHEMICAL COMPANY FELLOWSHIP — Available to graduate students in polymer science; stipend \$5,800.

CELANESE FELLOWSHIP — For information, contact the professor in charge of the program.

PPG FELLOWSHIP — Available to graduate students in polymer science; stipend \$6,336.

### POLYMER SCIENCE (PLMSC)

- 400. POLYMERIC MATERIALS (3)
- 403. FIELD TRIP (1)
- 406. INTRODUCTION TO THE MATERIALS SCIENCE OF POLYMERS (3)
- 407. POLYMER SCIENCE I (3)
- 409. POLYMER SCIENCE II (3)
- 410. MECHANICAL PROPERTIES OF POLYMERS AND COMPOSITES (3)
- 412. POLYMERIC MATERIALS LABORATORY — SYNTHESIS (2)
- 413. POLYMERIC MATERIALS LABORATORY — CHARACTERIZATION (2)
- 430. NATURAL POLYMERS (3)
- 490. POLYMER SCIENCE SEMINAR (1)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 500. ADVANCED POLYMERIC MATERIALS (3) In-depth discussions on the synthesis and properties of both novel and industrially significant polymers. Prerequisite: Plm.Sc. 400.
- 510. MULTICOMPONENT POLYMER SYSTEMS (3) A study of multicomponent polymer systems, including compatible and incompatible blends, interpenetrating networks, and reinforced elastomers and plastics. Prerequisite: Plm.Sc. 406.
- 511. SCATTERING TECHNIQUES APPLIED TO POLYMERS (3) A study of scattering techniques as applied to polymers, including discrete and diffuse small-angle X-ray and light scattering. Prerequisite: Phys. 203.
- 520. CRYSTALLINE POLYMERS (3) Morphology, characterization, and properties of crystalline polymers, including polymer crystals. Advanced characterization techniques as applied to crystalline polymers. Prerequisite: Plm.Sc. 407 or 409.
- 521. POLYMER VIBRATIONAL SPECTROSCOPY (3) The theory and application of infrared and Raman spectroscopy as applied to polymeric materials, including elementary normal coordinate calculations. Prerequisites: Math. 231, Phys. 203.



562. POLYMER CHARACTERIZATION LABORATORY (3) Selected experiments in advanced characterization of polymeric materials. Prerequisite: Plm.Sc. 406.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

## POULTRY SCIENCE (PTYSC)

KENNETH GOODWIN, *Head of the Department*  
 214 Animal Industries Building  
 814-865-3411

**Degree Conferred:** M.S.

### Senior Members of the Graduate Faculty

Kenneth Goodwin, Ph.D. (Cornell) *Professor of Poultry Science*  
 H. B. Graves, Ph.D. (V.P.I) *Professor of Poultry Science*  
 Roland M. Leach, Jr., Ph.D. (Cornell) *Professor of Poultry Science*

### Associate Members of the Graduate Faculty

Magdi M. Mashaly, Ph.D. (Wisconsin) *Assistant Professor of Poultry Science*  
 William B. Roush, Ph.D. (Oregon State) *Assistant Professor of Poultry Science*  
 Robert F. Wideman, Ph.D. (Connecticut) *Assistant Professor of Poultry Science*

The department offers two types of degree programs: (1) an M.S. degree in poultry science, with one of the following major fields of interest: animal nutrition, behavior, food science, genetics, management, or physiology; or (2) an M.S. or Ph.D. degree in one of the following disciplinary interdepartmental programs: animal nutrition, ecology, genetics, or physiology. In either case, direction of the student's program will be by a faculty member in the Department of Poultry Science. For the Ph.D., reading ability in one foreign language is required.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Admission requirements include 30 credits in the biological and physical sciences (chemistry, mathematics, and physics). Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

### Master's Degree Requirements

Students with professional interests other than research may earn the M.S. in Poultry Science without doing a thesis; in this option, a paper on a selected professional problem is required for graduation.

### Other Relevant Information

Students in the M.S. program may elect the dual-title degree program option in Operations Research (see p. 285).

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## POULTRY SCIENCE (PTYSC)

- 405. POULTRY PRODUCTION TECHNOLOGY (3)
- 462. (Biol. 462) ANIMAL BEHAVIOR — ETHOLOGY (3)
- 463. (Biol. 463) ANIMAL BEHAVIOR LABORATORY (1-2)
- 495. INTERNSHIP (8-10)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 502. POULTRY NUTRITION (2-4) *Leach*
- 582. (Biol. 582, Psy. 582) RESEARCH IN ANIMAL BEHAVIOR (2-6 per semester) Research in special areas of animal behavior involving field or laboratory work. *Graves and Hall*
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)

NOTE: See *Animal Science*.

## PSYCHOLOGY (PSY)

ROBERT M. STERN, *Head of the Department*  
417 Moore Building  
814-865-9514

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Thomas D. Borkovec, Ph.D. (Illinois) *Professor of Psychology*  
Paul R. Cornwell, Ph.D. (Michigan) *Professor of Psychology*  
W. Edward Craighead, Ph.D. (Illinois) *Professor of Psychology*  
Francis J. DiVesta, Ph.D. (Cornell) *Professor of Education and Psychology*  
Juris G. Draguns, Ph.D. (Rochester) *Professor of Psychology*  
James L. Farr, Ph.D. (Maryland) *Associate Professor of Psychology*  
Leon Gorlow, Ph.D. (Columbia) *Professor of Psychology*  
George M. Guthrie, Ph.D. (Minnesota) *Professor of Psychology*  
John F. Hall, Ph.D. (Ohio State) *Professor of Psychology*  
Rick R. Jacobs, Ph.D. (California) *Assistant Professor of Psychology*  
Frank J. Landy, Ph.D. (Bowling Green) *Professor of Psychology*  
Herschel W. Leibowitz, Ph.D. (Columbia) *Evan Pugh Professor of Psychology*  
Lynn S. Liben, Ph.D. (Michigan) *Associate Professor of Psychology*  
Richard M. Lundy, Ph.D. (Ohio State) *Professor of Psychology*  
Michael J. Mahoney, Ph.D. (Stanford) *Professor of Psychology*  
James E. Martin, Ph.D. (Illinois) *Associate Professor of Psychology*  
Gerald E. McClearn, Ph.D. (Wisconsin) *Professor of Individual and Family Studies, Human Nutrition, and Psychology*  
Harold E. Mitzel, Ph.D. (Minnesota) *Professor of Psychology and Education*  
Keith E. Nelson, Ph.D. (Yale) *Professor of Psychology*  
Merrill E. Noble, Ph.D. (Ohio State) *Professor of Psychology*  
David S. Palermo, Ph.D. (Iowa) *Professor of Psychology*  
Ellen V. Piers, Ph.D. (George Peabody) *Associate Professor of Psychology*  
Richard J. Ravizza, Ph.D. (Vanderbilt) *Associate Professor of Psychology*  
William J. Ray, Ph.D. (Vanderbilt) *Associate Professor of Psychology*  
K. Warner Schaie, Ph.D. (Washington) *Professor of Human Development and Psychology*  
Robert Seibel, Ph.D. (Iowa) *Associate Professor of Psychology*  
R. Lance Shotland, Ph.D. (Michigan State) *Associate Professor of Psychology*  
Robert M. Stern, Ph.D. (Indiana) *Professor of Psychology*  
Hoben Thomas, Ph.D. (Claremont) *Professor of Psychology*  
Hugh B. Urban, Ph.D. (Penn State) *Professor of Human Development and Psychology*  
John M. Warren, Jr., Ph.D. (Wisconsin) *Professor of Psychology*  
Walter B. Weimer, Ph.D. (Minnesota) *Associate Professor of Psychology*



**Associate Members of the Graduate Faculty**

Karen L. Bierman, Ph.D. (Denver) *Assistant Professor of Psychology*  
 David J. Brown, Ph.D. (Ohio State) *Affiliate Associate Professor of Psychology*  
 Frederick M. Brown, Ph.D. (Virginia) *Associate Professor of Psychology*  
 Marion Gindes, Ph.D. (Columbia) *Adjunct Associate Professor of Psychology*  
 Howard H. Hall, Ph.D. (Princeton) *Assistant Professor of Psychology*  
 Bennie Kathryn Mahoney, Ph.D. (Penn State) *Affiliate Assistant Professor of Psychology*  
 Melvin M. Mark, Ph.D. (Northwestern) *Assistant Professor of Psychology*  
 Gordon Shulman, Ph.D. (Oregon) *Assistant Professor of Psychology*  
 Francis L. Whaley, Ph.D. (Michigan) *Associate Professor of Psychology*

The graduate program in Psychology is designed to educate individuals for scholarly research, teaching, and professional careers in psychology. Instruction, teaching, and research opportunities are available in the following areas: clinical psychology; child and developmental psychology; experimental psychology with emphasis in language, human performance, perception, and human factors; comparative, physiological psychology, and psychophysiology; quantitative and mathematical psychology; social psychology; motor behavior and sport psychology; industrial/organizational. For admission and administrative purposes, students are accepted into one of six program areas: clinical; developmental; experimental; industrial/organizational; physiological; social. An individual's special pattern of interests dictates in part the course of study followed. Within all areas research is an integral part of study; usually, the research is empirical in focus, but it may be applied or basic depending on the problem of interest.

The department is located in a single building which contains laboratories specific to various areas, a PDP-1134 minicomputer, darkroom, and shop. Students have access to the large resources of the University, which include an excellent computation facility and large open-stack library. Opportunities for practicum experience are available; e.g., clinical students may be placed in local mental health centers, while industrial students may find placement in appropriate business or industrial settings.

**Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

In addition to satisfactory scores from the verbal and quantitative portions of the GRE, applicants must provide satisfactory scores from the Miller Analogies Test (MAT). Applicants with superior undergraduate (particularly junior and senior years) or graduate grade-point averages will be considered for admission.

Applicants should have a broad undergraduate background which includes 12 credits in psychology. Applicants are not necessarily expected to have a baccalaureate or graduate degree in psychology. Undergraduate study in psychology should include a course in statistics and a psychological methodology course.

Students are not usually accepted into the graduate program unless they are preparing for the doctoral degree.

**Master's Degree Requirements**

The psychology department does not have a graduate program designed for students seeking only the master's degree. The master's degree, or the department's equivalent, which is an acceptable published journal article, is required for advancement to candidacy for the Ph.D. degree in Psychology. Usually, but not always, the master's thesis centers on an empirical research topic. The typical thesis involves a literature review, data collection, analysis, and discussion. A master's degree is not awarded unless a thesis is submitted to the Graduate School.

**Doctoral Degree Requirements**

All students in their first year of residency must satisfactorily complete the department's English proficiency tests.

Students must complete (within their first 30 graduate credits for first-year students) 6 graduate credits in statistics, research design, or computer technology; each course must be completed with a grade of B or better. Additionally, students must complete, for graduate credit, courses in each of the

## PSYCHOLOGY

following four areas: biological, cognitive, social and industrial, and individual differences psychology. Only a grade of B or better in each course satisfies the requirement, which must be completed prior to Ph.D. candidacy. With each of two faculty members, in two separate areas of psychology, each student is expected to complete in two (preferably consecutive) semesters, 9 research credits. The Ph.D. comprehensive examination must be taken by the time 70 graduate credits are earned, or prior to the student's fourth year in residency, whichever comes first.

There is no departmental foreign language requirement.

### Other Relevant Information

The psychology department makes every effort to recruit and train minority psychologists. In 1969, the department unanimously adopted the ten-point plan of the Association of Black Psychologists. In the last ten years, thirty-six black students have been admitted to the program; twelve have received the Ph.D. Support for minority students is coordinated by the department, the Graduate School Minority Graduate Scholars Award Program, and the American Psychological Association Minority Fellowship Program.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

AMERICAN PSYCHOLOGICAL ASSOCIATION MINORITY PROGRAM FELLOWSHIPS — Students apply to the Department of Psychology, 417 Moore Building.

U.S. PUBLIC HEALTH SERVICE TRAINEESHIPS IN CLINICAL PSYCHOLOGY (10) — Available through the Department of Psychology; stipend \$3,780 for nine months plus tuition.

## PSYCHOLOGY (PSY)

- 402. SENSATION AND PERCEPTION (3)
- 404. CONDITIONING AND LEARNING (3)
- 405. THE EXPERIMENTAL PSYCHOLOGY OF VISUAL PERCEPTION (3)
- 407. BEHAVIOR GENETICS (3)
- 408. COMPARATIVE PSYCHOLOGY (3)
- 410. HISTORICAL ANTECEDENTS OF PSYCHOLOGY (3)
- 411. SYSTEMS OF PSYCHOLOGY AND THE RECENT PAST (3)
- 412. ABNORMAL PSYCHOLOGY (3)
- 414. HUMANISTIC PSYCHOLOGY (3)
- 415. INTERMEDIATE EXPERIMENTAL DESIGN (3)
- 417. SOCIAL PSYCHOLOGY (3)
- 419. MEASUREMENT AND DECISION MAKING (3)
- 420. (Ling. 420) ADVANCED PSYCHOLINGUISTICS (3)
- 421. ADVANCED COGNITIVE PSYCHOLOGY (3)
- 423. COGNITIVE DEVELOPMENT (3)
- 424. SOCIAL AND PERSONALITY DEVELOPMENT (3)
- 425. TOPICS IN DEVELOPMENTAL PSYCHOLOGY (3)
- 426. ADOLESCENCE (2-3)
- 430. PSYCHOLOGY OF MEMORY (3)
- 432. INTRODUCTORY ENGINEERING PSYCHOLOGY (3)
- 435. (M.E.R. 435) ENVIRONMENTAL STIMULATION AND BEHAVIOR (3)
- 436. MENTAL HEALTH IN SCHOOLS (3)
- 437. PSYCHOLOGY OF ADJUSTMENT (3)
- 438. THEORY OF PERSONALITY (3)
- 441. INDUSTRIAL MOTIVATION AND WORK SATISFACTION (3)
- 444. ATTENTION AND INFORMATION PROCESSING (3)
- 445. (I.F.S. 445) DEVELOPMENT THROUGHOUT ADULTHOOD (3)
- 450. (Ed.Psy. 450) PRINCIPLES OF MEASUREMENT (3)
- 451. LEADERSHIP IN WORK SETTINGS (3)
- 455. PHYSIOLOGICAL PSYCHOLOGY LABORATORY (3)
- 456. LABORATORY IN PSYCHOPHYSIOLOGY (4)
- 457. EXPERIMENTAL SOCIAL PSYCHOLOGY (4)
- 460. LEARNING AND MEMORY (3)



- 461. PERSONNEL TESTING AND INTERVIEWING (3)
- 470. (I.F.S. 470) SOCIAL LEARNING FOUNDATIONS OF BEHAVIOR CHANGE (3)
- 471. PSYCHOLOGY AND WOMEN (3)
- 474. PSYCHOLOGY OF EXCEPTIONAL CHILDREN (3)
- 479. (RI.St. 479) RELIGION AND CULTURE IN FREUDIAN THOUGHT (3)
- 481. PSYCHOLOGY OF INDUSTRIAL RELATIONS (3)
- 482. INTRODUCTION TO CLINICAL PSYCHOLOGY (3)
- 483. THE PSYCHOLOGY OF FEAR AND STRESS (3)
- 484. CLINICAL NEUROPSYCHOLOGY (3)
- 485. DEVELOPMENTAL BIOPSYCHOLOGY (3)
- 488. THE ANALYTICAL PSYCHOLOGY OF CARL JUNG (3)
- 489. PSYCHOLOGY OF CONSCIOUSNESS (3)
- 494. SENIOR THESIS (3-6)
- 495. PSYCHOLOGY PRACTICUM (1-10)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 505. RESEARCH PROBLEMS IN PSYCHOLOGY (1-15) Prerequisites: 12 credits in psychology.
- 510. HISTORY OF THE HIGHER MENTAL PROCESSES (3) Stress upon theoretical, conceptual, and methodological problems involved in studying human thinking, language, memory, cognition, and other skills. Prerequisite: Psy. 410 or 411.
- 511. SEMINAR IN CONTEMPORARY PSYCHOLOGY (1-9) Critical review of readings on a topic of current interest, either in content or methodology, within psychology. Prerequisites: 9 credits in psychology.
- 513. (Phil. 513) PRINCIPLES AND METHODS OF EMPIRICAL SCIENCE (3) Scientific methodologies and their presuppositions, with special emphasis on behavioral and social sciences.
- 515. ADVANCED STATISTICS IN PSYCHOLOGY AND EDUCATION (3) Correlation theory and methods, discriminant analysis, and factor analysis; applications to mental test theory. Prerequisite: Psy. 415 or Ed.Psy. 506.
- 517. ADVANCED SOCIAL PSYCHOLOGY (3) Problems of theory and of research methods with emphasis on persisting issues relevant to contemporary developments in social psychology. Prerequisites: Psy. 417; Psy. 15 or Stat. 200.
- 520. (Ling. 520) SEMINAR IN PSYCHOLINGUISTICS (3) Consideration of theoretical and research issues relevant to psychological aspects of language sounds, syntax and semantics, and other cognitive support.
- 522. PERSONNEL SELECTION AND APPRAISAL (3) Evaluation of models for personnel selection, placement, and performance appraisal in business and industry. Prerequisites: Psy. (Ed.Psy.) 450, Psy. 461.
- 523. SOCIAL-ORGANIZATION PSYCHOLOGY IN INDUSTRY (3) Analysis of the role of social and organizational variables as they affect employee performance and employee attitudes. Prerequisite: Psy. 441.
- 527. STATISTICAL INFERENCE AND EXPERIMENTAL DESIGN (3) Probability theory, sampling distributions, analysis of variance and covariance, analysis of trend, nonparametric statistics, experimental design. Prerequisite: Psy. 415 or Ed.Psy. 506.
- 529. (I.F.S. 529) SEMINAR IN CHILD DEVELOPMENT (1-6) Readings and reports on recent findings in child development. Prerequisites: 6 graduate credits in child development, child psychology, or educational psychology, plus 3 in statistics.
- 531. SEMINAR IN PERFORMANCE THEORY (3-9) Topics in theory and research on human performance in perceptual-motor and information-processing tasks. Prerequisite: Psy. 432.
- 533. ADVANCED ENGINEERING PSYCHOLOGY (3) Analysis of the role of the human operator in man-machine systems. Prerequisite: Psy. 432.
- 534. PRACTICUM IN INDUSTRIAL/ORGANIZATIONAL PSYCHOLOGY (1-3) Supervised application of psychological principles in industrial and governmental settings. Prerequisites: Psy. 441, 461.

535. DEVELOPMENTAL PSYCHOLOGY (2-3) Developmental principles and concepts applied to psychological processes, with special reference to the experimental literature. Prerequisites: 9 credits in psychology.
536. (I.F.S. 536) RESEARCH METHODS IN DEVELOPMENTAL PROCESSES (3) Methodological issues in research on varying stages of development across the individual life-span. Prerequisites: 6 credits in individual development or psychology, and a course in statistics.
538. PSYCHOLOGY OF PERSONNEL DEVELOPMENT (3) Industrial training in relation to psychological learning theory and experimental findings. Prerequisite: Psy. 461 or Ed.Psy. 421.
540. SEMINAR IN CLINICAL PROBLEMS (1-9) Contemporary psychological theory, research, and methodology in relation to clinical psychology. Prerequisites: Psy. 542, 560.
541. PERSONALITY THEORY (3-4) Contemporary theories of personality; relevant research. Prerequisite: Psy. 438.
542. PSYCHOPATHOLOGY (3-4) Theories of pathological behavior with reference to clinical and experimental data. Prerequisite: Psy. 412.
543. RESEARCH DESIGN IN CLINICAL PSYCHOLOGY (3) Experimental and quasi-experimental designs, methodological problems, and techniques of experimental control in clinical psychology research. Prerequisite: 3 credits of statistics.
544. PSYCHOLOGICAL HYPNOSIS (3) Theory and research in psychological hypnosis. Techniques in the induction and clinical applications of hypnosis.
549. (I.F.S. 549) DEVELOPMENTAL THEORY (3) Conceptual frameworks and major contributions to the study of individual development across the life-span. Prerequisites: 6 credits at the 400 level in individual development or psychology.
555. THEORY AND PRACTICUM IN CLINICAL ASSESSMENT (3-9) Theoretical issues and research in clinical assessment with special reference to administration and interpretation of testing procedures and clinical interviewing. Prerequisites: Psy. 541 or 542, and a course in measurement.
558. CLINICAL CHILD PSYCHOLOGY (3-9) Psychopathology of childhood; theories of etiology; diagnosis and treatment. Prerequisites: Psy. 555, 561.
559. (S.Psy. 559) THE INDIVIDUAL PSYCHOLOGICAL EXAMINATION (3) Demonstrations and practice in widely used ability and aptitude tests; psychological report writing. Prerequisites: 15 credits in psychology and a course in measurement.
560. PRACTICUM IN CLINICAL METHODS (1-6) Supervised practice in the Psychology Clinic, including assessment, therapy, report writing, and staff participation. Prerequisite: Psy. 555.
561. CLINICAL PRACTICUM WITH CHILDREN (1-6) Diagnosis and counseling of child-parent problems of learning and adjustment. Prerequisites: Psy. 425, 426, 555.
563. BEHAVIOR MODIFICATION I (3) Conceptual foundations of principles, assessment methods, and research strategies.
564. BEHAVIOR MODIFICATION II (3) Survey and empirical evaluation of treatment strategies. Prerequisite: Psy. 563.
565. SEMINAR IN COMMUNITY PSYCHOLOGY (3) Application of social psychological research methods and principles to prevention and alleviation of behavior disorders in family and community settings.
566. CULTURAL PSYCHOLOGY (3) Experimental and descriptive research on culture and behavior in both Western and non-Western settings. Prerequisites: Psy. 417, 438, and 6 credits in statistics.
569. ADVANCED THEORY AND PRACTICUM IN COUNSELING AND PSYCHOTHERAPY (3-9) Theoretical issues, research, and practicum experience in psychotherapy.
571. SEMINAR IN SOCIAL PSYCHOLOGY (3-9) Historical development of theory and methods; determinants and principles of complex social or interactional behavior; contemporary problems and research.
580. THEORY AND CONSTRUCTION OF ATTITUDE SCALES (3) Techniques for measuring attitudes and related intraindividual constructs; reliability and validity; attitude measurement procedures; multidimensional scaling; multiple indicator models. Prerequisite: 3 credits of 500-level statistics.



582. (Biol. 582, Pty.Sc. 582) **RESEARCH IN ANIMAL BEHAVIOR** (2-6 per semester) Research in special areas of animal behavior involving field or laboratory work.
583. **DESIGNING RESEARCH IN SOCIAL PSYCHOLOGY** (3) Designs and procedures useful in social psychology and cognate disciplines; quasiexperimental designs and analysis, field experimentation, validity of inferences. Prerequisite: 3 credits of 500-level statistics.
584. (Soc. 584) **ATTITUDE FORMATION AND CHANGE** (3) Theory and method in research on attitude formation and change with emphasis on critical analysis. Prerequisites: Psy. 417 or Soc. 403; 3 credits in statistics.
585. (Soc. 585) **INTERACTION PROCESSES WITHIN AND BETWEEN GROUPS** (3) Interactions in personal, group, and intergroup relations; theory and observational methods. Prerequisites: Psy. 417 or Soc. 403.
586. (Soc. 586) **THE SOCIAL PSYCHOLOGY OF SOCIAL CHANGE** (3) The interaction of individual, social, and cultural determinants of group and individual change; emphasis on social movements, crowds, and audiences. Prerequisites: Psy. 417 or Soc. 403.
587. (Soc. 587) **SOCIALIZATION** (3) Behavioral, cognitive, developmental, symbolic, interactionist, and role theories of socialization; emphasis on current theory and research. Prerequisites: Psy. 417 or Soc. 403.
588. (Soc. 588) **THE SOCIAL ORGANIZATION OF ATTRIBUTION** (3) Principles of attribution and their relevance to such topics as power relations, authority, equity, injustice, and social movements. Prerequisites: Psy. 417 or Soc. 403.
591. **SEMINAR ON TEACHING PSYCHOLOGY** (1-3) Objectives and content of psychology; organization and presentation of material; teaching aids and techniques.
596. **INDIVIDUAL STUDIES** (1-9)
597. **SPECIAL TOPICS** (1-9)
602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING** (1-3 per semester, maximum of 6)

## PSYCHOSOCIAL SCIENCE (PS SC)

JAMES R. HUDSON, *In Charge of the Graduate Program in Psychosocial Science*  
The Capitol Campus  
Middletown, PA 17057  
717-948-6064

**Degree Conferred:** M.Ps.Sc. (Master of Psychosocial Science)

### Senior Members of the Graduate Faculty

James R. Hudson, Ph.D. (Michigan) *Associate Professor of Social Science and Sociology*  
Kenneth W. Masters, Ph.D. (Pennsylvania) *Professor of Social Science*  
Kathryn Towns, Ph.D. (Penn State) *Associate Professor of Educational Psychology*  
James O. Whittaker, Ph.D. (Oklahoma) *Professor of Social Science and Psychology*

### Associate Members of the Graduate Faculty

Michael L. Barton, Ph.D. (Pennsylvania) *Assistant Professor of Social Science and American Studies*  
Robert W. Colman, Ph.D. (North Carolina) *Assistant Professor of Social Science and Psychology*  
Joseph E. Dreiss, Ph.D. (Duquesne) *Assistant Professor of Psychology*  
Ida Marie Gentzler, M.Ps.Sc. (Penn State) *Instructor in Social Science*  
Herbert M. Hunter, Ph.D. (Boston) *Assistant Professor of Social Science and Sociology*  
Sandra Prince-Embury, Ph.D. (Pennsylvania) *Assistant Professor of Psychology*  
John A. Teske, Ph.D. (Clark) *Assistant Professor of Psychology*

The graduate program in Psychosocial Science leads to a Master of Psychosocial Science degree, Community Psychology major. This is a nontraditional degree program with emphasis on experience in carrying out a master's project. The program is concerned with equipping students with some of the skills necessary to cope with the multifaceted problems facing communities. Students should learn to recognize problems, to outline and implement possible solutions to these problems, and to evaluate the effectiveness of the solution.

To perform these functions the student must be aware of contemporary community needs, the impact of the community structure upon its individual members, and the techniques best suited to initiate productive changes. After completing this interdisciplinary program, the graduate should be able to approach problems with a more integrated point of view and work cooperatively with community individuals and agencies toward practical solutions. Problems in drug abuse, delinquency, unemployment, housing, and other areas affecting mental health are approached from a community service agency base or from less formal community groups dealing with the same problems. At present approximately 90 percent of all students work full time in agencies or governmental units. To accommodate them, most graduate 500-level courses are scheduled in the evening, with a few given during the day.

### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in the program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

For admission to the program, the grade-point average in the junior and senior years must be 2.50 or higher. Most applicants have degrees in psychology, sociology, or related disciplines. Students with other backgrounds may apply, particularly if they have had experience in community agencies. Students are expected to be familiar with elementary statistics and will be requested to make up any deficiency without graduate credit.

Off-campus and transfer credits will be evaluated by an admissions committee of at least three members of the graduate faculty. Approval for up to 12 transfer credits may be given. Application for work experience to be counted as practicum credits will be evaluated by members of the graduate faculty. Approval for up to 6 credits may be given. If credit is approved, the applicant must register for Ps.Sc. 522 for the number of credits granted. The courses in the program are scheduled with the assumption that students will enter in the fall semester. Students may apply for admission for any semester, but they may have to wait one or more semesters for particular required courses.

Applicants must submit the following: a completed application form; the application fee (\$20); two copies of official transcripts from colleges or universities previously attended (including The Pennsylvania State University); a two- to three-page proposal outlining an actual social problem and a means of ameliorating that problem, identifying skills, materials, and/or facilities needed to work on the problem; the results of the Graduate Record Examination General Aptitude Test, Verbal and Quantitative scores.

The application, fee, transcripts, proposal letter, and test scores should be sent to Graduate Admissions, The Capitol Campus, The Pennsylvania State University, Middletown, PA 17057. In addition, applicants may be requested to visit the campus for an interview.

### **Degree Requirements**

To qualify for the degree, 37 credits are required, 25 at the 500 level. An important part of this degree is a 6-credit fieldwork requirement, supervised by a faculty member. This required practicum experience ordinarily is taken for one semester. A master's paper of a minimum of 3 credits is required and may employ the field experience. Students who have considerable experience and clarified interest upon entering the program or students with a strong research interest may want to structure their master's paper around a specific community research problem. If the master's paper comes from the field experience, the faculty field supervisor will serve on the master's paper committee. Most part-time students are able to complete the degree in four to five semesters; the full-time student, in three to four semesters.

### **Student Aids**

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.



**PSYCHOSOCIAL SCIENCE (BE SC)**

- 401. SEMINAR IN BEHAVIORAL SCIENCE (1-6)
- 407. SMALL GROUPS (3)
- 421. BEHAVIOR MODIFICATION (4)
- 440. THE CITY (4)
- 443. SOCIAL CONFLICT (4)
- 461. THEORIES AND MODELS OF COUNSELING (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 500. THEORIES AND ISSUES IN COMMUNITY PSYCHOLOGY (3) Contemporary issues in community psychology will be discussed within the framework of its development from clinical and social psychology.
- 511. PSYCHOPATHOLOGY IN A SOCIAL CONTEXT (3) Psychopathology in the context of other forms of social deviancy, with attention to both social and individual concomitants of deviancy.
- 512. THEORIES AND MODELS OF PSYCHOTHERAPY (3) Survey of methods/theories used to treat mental illness or to change dysfunctional behavior. Prerequisites: Ps.Sc. 461, 511.
- 521. ROLES AND METHODS IN COMMUNITY PSYCHOLOGY (3) Course examines and synthesizes roles, methods, and competencies relevant to community psychology, including students to utilize them in applied settings. Prerequisite: permission of instructor.
- 522. PRACTICUM (3-6) Experience in a field setting with problems confronting both clients and social welfare agencies. Prerequisite: Ps.Sc. 522.
- 530. RESEARCH (1-6) Supervised research on a master's paper. For degree candidates only.
- 535. BEHAVIORAL MANAGEMENT (3) Analysis of the social determinants of behavior and behavioral ecology. Emphasis on data collection and evaluation techniques. Prerequisite: Ps.Sc. 421.
- 570. ADVANCED EXPERIMENTAL DESIGN (3) A survey of advanced statistical methods and experimental design techniques for community psychology, behavior management, and the social sciences. Prerequisites: Scl.Sc. 470, 520.
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)

**SOCIAL SCIENCE (SCLSC)**

- 470. ADVANCED STATISTICAL AND DESIGN METHODS (4)
  
- 510. CHANGE PROCESSES (3) Social change as it takes place within institutions and communities.
- 520. TECHNIQUES IN ACTION RESEARCH (3) Methods for evaluating programmatic change. Prerequisite: Scl.Sc. 320.
- 531. THE FUNCTIONING NEIGHBORHOOD (3) A study of small communities and techniques for observing them, coupled with field experience in participant observation of a specific neighborhood.
- 532. COMMUNITY ORGANIZING: CONFLICT AND CHANGE (3) The development of local issues and strategies for organizing around them.
- 533. PROBLEMS OF THE DISENFRANCHISED (3) Problems confronting minority or low-power groups, with an emphasis on the poor, blacks, and women.
- 541. THE ORGANIZATION OF HUMAN SERVICES (3) Divisions of labor among social agencies; internal and external factors affecting the ordering of priorities.
- 543. COMPLEX ORGANIZATIONS: CHANGE AND RESISTANCE (3) Structure and function in large organizations and case studies of change.
- 590. COLLOQUIUM (1-3)
- 597. SPECIAL TOPICS (1-9)

## PUBLIC ADMINISTRATION (PUB A)

ROBERT LA PORTE, JR., *Acting Director of the Institute of Public Administration*  
205 Burrowes Building  
814-865-2536

**Degree Conferred:** M.P.A.

### Senior Members of the Graduate Faculty

Robert La Porte, Jr., Ph.D. (Syracuse) *Professor of Public Administration*  
Robert D. Lee, Jr., Ph.D. (Syracuse) *Professor of Public Administration*  
Theodore H. Poister, Ph.D. (Syracuse) *Associate Professor of Public Administration*  
John M. Stevens, Ph.D. (S.U.N.Y., Buffalo) *Assistant Professor of Public Administration*

### Associate Members of the Graduate Faculty

David N. Allen, Ph.D. (Indiana) *Assistant Professor of Public Administration*  
Robert P. McGowan, Ph.D. (Syracuse) *Assistant Professor of Public Administration*

The Master of Public Administration degree program provides graduate professional education for individuals preparing to enter public service and for those mid-level government officials who have had substantial experience but require professional training in administration and management. The degree program has been designed to provide students with an understanding of the theories of organization, with particular reference to organizations functioning within the public sector; research methodologies for the analysis of complex systems and for seeking operational solutions to problems; management technologies, including the use of sophisticated information systems for the maintenance of ongoing decision-making systems. Students also have an opportunity to acquire specialized knowledge in areas such as urban affairs, human services administration, budgeting and financial management, management information systems, and personnel management.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Candidates for admission ordinarily have taken at least 12 credits of undergraduate work in the social sciences. Candidates for the degree may be required to take some courses without graduate credit in order to complete a major designed for their professional needs.

Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests. Scores from the Graduate Management Aptitude Test (GMAT) or the Law School Aptitude Test (LSAT) may be submitted in place of the GRE. Two letters of recommendation are required and should be sent directly to the institute. Although course work may be taken at University Park or at the King of Prussia Center for Graduate Studies, admission must be authorized by the University Park program director.

### Degree Requirements

All degree candidates take a required core program of seven seminars covering the theoretical, methodological, and technological components of public administration. Additional credits of electives may be clustered around a chosen area of specialization.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

U.S. OFFICE OF EDUCATION PUBLIC SERVICE FELLOWSHIPS — Available through the Institute of Public Administration at the University Park Campus; a stipend of up to \$4,500 for twelve months and tuition. Fellowships are awarded only to students in the Master of Public Administration degree program at the University Park Campus.



**PUBLIC ADMINISTRATION (PUB A)**

400. INTRODUCTION TO THE AMERICAN ADMINISTRATIVE SYSTEM (3)
402. METHODS OF PROGRAM ANALYSIS (3)
403. PUBLIC MANAGEMENT TECHNOLOGY (3)
404. URBAN MANAGEMENT (3)
445. ADMINISTRATIVE LAW (3)
496. INDEPENDENT STUDIES (1-18)
497. SPECIAL TOPICS (1-9)
569. DOCTRINE AND PRACTICE OF PUBLIC ADMINISTRATION (3) Evolution of American public administration; doctrine of enforcement, the service state, the laissez-faire state; accountability and ethics. *La Porte*
570. ADMINISTRATION IN MULTI-JURISDICTIONAL SYSTEMS (3) Analysis of multi-jurisdictional constraints on administration; design of strategies for developing and executing programs in a pluralistic institutional setting. *La Porte, Lee, and Poister*
571. THEORY OF PUBLIC ADMINISTRATION (3-6) The role of the executive in modern government; the objectives of public administration; theories of administrative organization and practice. *McGowan and Stevens*
572. (Pl.Sc. 572) INTERNATIONAL DEVELOPMENT ADMINISTRATION (3-6) The examination of bilateral and multilateral development assistance programs; planning, implementation, and evaluation of development programs in LDCs. *La Porte*
573. (Pl.Sc. 573) COMPARATIVE PUBLIC ADMINISTRATION (3-6) Administrative systems of selected nations on a functional basis; relationship between culture, economic and social systems, and public administration. *La Porte*
574. (Pl.Sc. 574) SEMINAR IN THE ADMINISTRATION OF UNITED STATES FOREIGN AFFAIRS (3) Effect of cross-cultural operations on the normal process of administration of United States foreign affairs. *La Porte*
575. GOVERNMENT PERSONNEL MANAGEMENT (3) Current trends in personnel systems; classification, pay, examination, performance evaluation, discipline, career development, employee rights, equal opportunity, labor-management relations. *La Porte, Lee, McGowan, and Stevens*
576. GOVERNMENT BUDGETING (3) Budget preparation, approval, execution, audit; program information and evaluation in decision making; expenditure control; revenue policies and administration; intergovernmental finance. *La Porte and Lee*
577. ORGANIZATION AND SYSTEMS MANAGEMENT (3) Organizations as systems; decision making; systems analysis and methods; project and program management; role of information systems; systems design. *Allen and Stevens*
578. URBAN ADMINISTRATIVE SYSTEMS (3) Managing under conditions of urban growth and decay; alternative delivery systems for urban and metropolitan services in selected program areas. Prerequisite: Pub.A. 404. *Allen, Lee, and Poister*
579. METHODS OF ANALYSIS AND MEASUREMENT IN PUBLIC ADMINISTRATION (3 per semester, maximum of 6) Examination and application of analytical techniques for evaluating organizational performance and program effectiveness in government agencies. *Allen and Poister*
581. PUBLIC MANAGEMENT INFORMATION SYSTEMS (3) Examination of the role of management information in public organizations; establishment of information requirements for public programs. Prerequisites: Pub.A. 571, 579. *McGowan and Stevens*
582. LEGISLATIVE MANAGEMENT AND OVERSIGHT FUNCTIONS (3) Examination of the role of the legislature in overseeing the executive; emphasis on financial and program analysis techniques and problems.
583. ADVANCED PROGRAM/POLICY ANALYSIS (3) Advanced research methods and quantitative techniques as applied to needs assessment and program performance evaluation of public programs. Prerequisites: 6 credits of Pub.A. 579 or other similar course work. *Poister*
586. GOVERNMENT FINANCIAL MANAGEMENT AND ACCOUNTING (3) Public sector financial management, capital budgeting, revenue, cash management, debt management, governmental accounting and auditing, reporting systems. *Lee and Stevens*

## PUBLIC ADMINISTRATION

587. HUMAN SERVICES ADMINISTRATION WORKSHOP (3) Workshop of design on management infrastructure for a comprehensive multiprogram/multiagency human services system. Prerequisites: minimum of one year's experience in a human services agency (welfare, social services, health, mental health, developmental disabilities, aging, special education) or consent of instructor; 15 graduate credits in public administration or one of the above program areas. *Lee*

589. PUBLIC ADMINISTRATION COMPUTER APPLICATIONS (1-3) Introduction to computer applications in public administration; instruction in packaged computer programs for statistical analysis/program evaluation.

591. (Pl.Sc. 591) NATIONAL SECURITY ADMINISTRATION (3) National security system defense organization, decision making, and administration supply management; contract administration and procurement impact of defense expenditures.

594. RESEARCH SEMINAR IN PUBLIC ADMINISTRATION (1-6) Application of research methods to problems of organization, management, and policy in public agencies; preparation of research project and report. *La Porte*

595. INTERNSHIP IN PUBLIC ADMINISTRATION (1-6) *La Porte*

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

## PUBLIC ADMINISTRATION (P ADM)

CHRISTOPHER K. McKENNA, *Head, Division of Public Affairs*  
The Capitol Campus  
Middletown, PA 17057  
717-948-6050

**Degree Conferred:** M.P.A.

### Senior Members of the Graduate Faculty

Rupert F. Chisholm, Ph.D. (Case Western Reserve) *Associate Professor of Management*  
Francis Ferguson, Ph.D. (Columbia) *Professor of Environmental Design*  
Kenneth W. Masters, Ph.D. (Pennsylvania) *Professor of Social Science*  
Robert E. McDermott, Ph.D. (Duke) *Professor of Environmental and Health Systems*  
Christopher K. McKenna, Ph.D. (New York) *Associate Professor of Management Science*  
Robert F. Munzenrider, Ph.D. (Georgia) *Associate Professor of Public Administration*  
James E. Skok, Ph.D. (Maryland) *Associate Professor of Public Administration*

### Associate Members of the Graduate Faculty

Robert J. Bresler, Ph.D. (Princeton) *Associate Professor of Public Policy*  
Sherman Folland, Ph.D. (Iowa) *Assistant Professor of Health Policy and Economics*  
Carol Nechemias, Ph.D. (Ohio State) *Assistant Professor of Public Policy*  
Lloyd W. Woodruff, Ph.D. (Minnesota) *Associate Professor of Public Administration*

The Capitol Campus M.P.A. program is approved by the National Association of Schools of Public Affairs and Administration. It is intended to prepare individuals for professional careers as administrators, project directors, or staff analysts in local, state, or federal government; health care organizations; human service and public safety agencies; and other service organizations.

The location of the Capitol Campus at the state capital of Pennsylvania provides excellent opportunities for field study experiences in state government agencies, cities and smaller municipalities, county and federal agencies, large hospitals, Penn State's Milton S. Hershey Medical Center, and other professional and public-service organizations. The 9-credit field study, which extends over two semesters, may be waived for students who have at least three years of full-time related professional experience.

Current areas of faculty research interests include quality of worklife, organizational change, computers in public administration, the legislative process, the budget process, health policy and planning, oversight and evaluation, state government decision making, and political campaigns.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for*



*admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

The program requires the scores from one of the following examinations: Graduate Record Examination (GRE), Graduate Management Admissions Test (GMAT), Miller Analogies Test (MAT), or Law School Admissions Test (LSAT).

Applicants will submit a short essay outlining their career plans.

Students with a 3.00 junior-senior average will be considered for admission. Exceptions may be made for applicants with special backgrounds, abilities, and interests, or with professional experience. Applicants are expected to have had, through course work or experience, some preparation in American government, algebra, introductory statistics, economics, accounting, computer methods, and behavioral sciences. Students without such preparation may take non-graduate-credit courses offered by the program.

### **Degree Requirements**

The M.P.A. degree requires a minimum of 45 credits, including 9 credits of a faculty-supervised field study in public agency in the student's field of interest. This requirement may be waived for students who have at least three years of full-time professional experience in relevant administrative or staff work prior to graduation.

Students complete a master's paper, either as part of their field study experience or as one of their electives. The master's project is a professional paper or other undertaking rather than an academic thesis.

There is no foreign language requirement.

Consistent with the view that an M.P.A. degree is broad based, the program requires the following courses: P.Adm. 500 — Public Organization and Management; P.Adm. 501 — Administration and the Political Process; P.Adm. 502 — Government Fiscal Decision Making; P.Adm. 503. — Research Methods; P.Adm. 504 — Legal and Social Context of Public Administration; P.Adm. 510 — Organization Behavior. The student completes six other courses. Electives are available in a variety of areas such as state and local government, human resources, public systems, human services management, financial management, and business.

There is no qualifying or comprehensive examination.

### **Student Aids**

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

U.S. OFFICE OF EDUCATION PUBLIC SERVICE FELLOWSHIP — Provides tuition plus a stipend.

Research aide positions, offering a stipend approximately equal to the tuition for full-time study, and paying internships with various governmental and other service organizations also are available.

### **PUBLIC ADMINISTRATION**

P.ADM. 390G. ACCELERATED AMERICAN GOVERNMENT (2) The structure and processes of American national, state, and local government, including legislative, executive, and judicial. For graduate students only.

P.ADM. 391G. QUANTITATIVE METHODS REVIEW FOR PUBLIC ADMINISTRATION (2) An accelerated review of selected techniques from algebra and finite mathematics applied to public management problems.

P.ADM. 393G. INTRODUCTORY GOVERNMENTAL AND NOT-FOR-PROFIT ACCOUNTING (2) Accounting concepts and techniques needed by the public administrator for financial decision making and control.

P.ADM. 394G. ACCELERATED ECONOMIC ANALYSIS (2) A study of concepts of the allocation of resources, the distribution of income, and the level of aggregate economic activity. For graduate students only. (Not available for business students.)

- P.ADM. 440. HEALTH SYSTEMS ORGANIZATION (3) Health care policy issues, economics, planning, institutional/ambulatory care delivery, programs, manpower, technology, systems reform; public sector emphasis. Prerequisite: Sci.Sc. 350.
- P.ADM. 500. PUBLIC ORGANIZATION AND MANAGEMENT (3) Development of public administration; administrative theory and practice in public organizations.
- P.ADM. 501. ADMINISTRATION AND THE POLITICAL PROCESS (3) Analysis of the relationship of administration to the political processes that shape public policy formulation and execution. Prerequisites: 3 credits of American government and 3 credits of micro/macro economics.
- P.ADM. 502. GOVERNMENTAL FISCAL DECISION MAKING (3) Nature, function, and technique of governmental budgeting viewed as mechanism for allocating resources among alternative public uses. Prerequisites: P.Adm. 500, 501.
- P.ADM. 503. (R.Pl. 500) RESEARCH METHODS (1-3) Examination of research methodologies relevant to administration, planning, and public policy. Prerequisite: 3 credits in statistics.
- P.ADM. 504. LEGAL AND SOCIAL CONTEXT OF PUBLIC ADMINISTRATION (3) The legal framework for public administration, the administration of public law, conduct of legal research, and socio-legal issues. Prerequisite: 3 credits in American government.
- P.ADM. 505. PERSONNEL MANAGEMENT: PUBLIC AND NONPROFIT SECTOR (3) Concepts and approaches contributing to effective use of human resources in public and nonprofit organizations; legal issues and requirements. Prerequisites: P.Adm. 500, 510.
- P.ADM. 510. (Mngmt. 510) ORGANIZATION BEHAVIOR (3) Examination of concepts of human behavior in formal organizations, systems analysis, conceptual models, and decision processes. Prerequisite: P.Adm. 500.
- P.ADM. 511. (Mngmt. 511) ORGANIZATIONAL CHANGE AND DEVELOPMENT (3) Theory of organizational change and development; case analysis of applications in actual situations. Prerequisites: P.Adm. 500, 510.
- P.ADM. 515. (Mngmt. 515) LABOR MANAGEMENT RELATIONS (3) Labor relations issues; collective bargaining agreement, negotiations, and administration; legal framework of collective bargaining; labor relations in larger social context.
- P.ADM. 520. MANAGEMENT SCIENCE APPLICATIONS (3) Applications of quantitative models for the administrator's viewpoint. Explanation of the underlying models, assumptions made, questions explored, without mathematical detail. Prerequisites: P.Adm. 502, 503.
- P.ADM. 522. GOVERNMENT FINANCIAL MANAGEMENT (3) Theories and techniques of financial planning and control with emphasis on their application in government and nonprofit agencies. Prerequisites: P.Adm. 502 and 3 credits of accounting.
- P.ADM. 524. ADMINISTRATIVE LAW (3) Statutory and judicial controls upon administrative discretion. Administration of rule making, rate setting, licensing, adjudication. Judicial review and citizen advocacy. Prerequisites: P.Adm. 500, 501, 502.
- P.ADM. 530. FIELD STUDY IN PUBLIC ADMINISTRATION (1-5 per semester, maximum of 9) Analysis and written reports on current problems/projects for a public agency in student's concentration area. Readings in concentration area. Prerequisite: permission of program chairman.
- P.ADM. 532. URBAN GOVERNMENT (3) Administrative processes and policy problems associated with managing urban communities; political, intergovernmental, fiscal, structural, and analytical concepts in urban government.
- P.ADM. 540. ADMINISTRATIVE POLICY FORMULATION (3) Analysis of administrative problems from a total organization viewpoint. Case studies of actual organizations are used for analysis.
- P.ADM. 541. HEALTH ECONOMICS AND POLICY (3) Public policy issues, health system components from economic perspective. Economic analysis of health sector, medical markets, health care regulation. Prerequisites: P.Adm. 400 and introductory economics.
- P.ADM. 545. HEALTH FINANCIAL MANAGEMENT (3) Theory and techniques of financial management applied to health organizations; forecasting, control systems, working capital, capital budgeting, and institutional financing. Prerequisites: P.Adm. 400, 541, and elementary accounting.



P.ADM. 546. **HEALTH PLANNING FOR PUBLIC ADMINISTRATION (3)** Comprehensive planning and program planning for health services, facilities, and manpower; social, economic, and political considerations; methodological problems. Prerequisites: P.Adm. 503, 541.

P.ADM. 550. **PROGRAM PLANNING AND EVALUATION (3)** Analysis and evaluation of public programs and systems from the perspectives of policy development and administrative planning and management. Prerequisite: P.Adm. 503 or permission of instructor.

P.ADM. 554. **MASTER'S PROJECT (1-3)** Student independently executes an applied professional or research project, involving the analysis of a management or a public policy problem. Prerequisite: P.Adm. 503.

P.ADM. 556. **STATE GOVERNMENT ADMINISTRATION (3)** Study of structures, systems, processes, problems, and issues affecting state government administration; case studies, field observations, and research. Prerequisites: P.Adm. 500, 501.

P.ADM. 557. **FEDERALISM AND INTERGOVERNMENTAL RELATIONS (3)** Study of the impact of a federal system of government on the administration of public functions. National-state-local dimensions. Prerequisites: P.Adm. 500, 501.

P.ADM. 558. **LEGISLATIVE PROCESSES (3)** Legislatures in American government emphasizing comparative state legislatures: constitutional patterns; organization, administration; interaction with bureaucracy, constituencies, and organized interests. Prerequisites: P.Adm. 500, 501.

P.ADM. 590. **COLLOQUIUM (1-3)**

P.ADM. 596. **INDIVIDUAL STUDIES (1-9)**

P.ADM. 597. **SPECIAL TOPICS (1-9)**

## RECREATION AND PARKS (RC PK)

PATRICIA FARRELL, *Head of the Department*  
267 Recreation Building  
814-865-1851

**Degrees Conferred:** Ph.D., M.S., M.Ed.

### Senior Members of the Graduate Faculty

Geoffrey C. Godbey, Ph.D. (Penn State) *Professor of Recreation and Parks*  
Herberta M. Lundegren, Ph.D. (Iowa) *Professor of Physical Education*  
Karl G. Stodefalte, Ph.D. (Illinois) *Professor of Physical Education*

### Associate Members of the Graduate Faculty

David R. Chase, Ph.D. (Texas A&M) *Associate Professor of Recreation and Parks*  
Jerold E. Elliott, Ph.D. (Indiana) *Associate Professor of Recreation and Parks*  
Patricia Farrell, D.Ed. (Penn State) *Associate Professor of Recreation and Parks*  
Frank B. Guadagnolo, Ph.D. (Oregon State) *Assistant Professor of Recreation and Parks*  
Dan W. Kennedy, Ph.D. (Maryland) *Assistant Professor of Recreation and Parks*

The graduate program is designed to prepare students for administrative, supervisory, research, and teaching positions in public and private recreation and park systems, in colleges and universities, in voluntary agencies and institutions, and in commercial ventures.

The program is oriented to meet the specific needs and research interests of the candidate. Students may pursue interests in the community, including public park and recreation systems, voluntary agencies, and private enterprises; institution and community-oriented therapeutic settings concerned with many different disabilities and utilizing a variety of activity modalities; park planning, interpretive services, outdoor education, and outdoor recreation services.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are*

## RECREATION AND PARKS

*in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

For admission to the graduate program, a bachelor's or master's degree is required. Candidates from majors other than recreation and parks are welcome to apply; however, additional course work is required. Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. All students must write a thesis.

### **Master's Degree Requirements**

There are no additional requirements beyond the general Graduate School requirements for the master's degree. Doctoral degree requirements include a 3.20 average for the master's degree work; one foreign language; computer competency; and at least one year's experience in the recreation and parks field before completion of the degree.

### **Student Aids**

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following award typically has been available to graduate students in this program:

U.S. OFFICE OF EDUCATION TRAINEESHIPS IN THERAPEUTIC RECREATION — Open to graduate students specializing in therapeutic recreation; stipend \$2,250 (three semesters). Apply through the Graduate Program in Recreation and Parks.

## **RECREATION AND PARKS (RC PK)**

- 425. INTERPRETIVE SERVICES (3)
- 430. OUTDOOR EDUCATION METHODS AND MATERIALS (3)
- 433. EVALUATION IN RECREATION AND PARKS (3)
- 434. FUNCTIONAL PLANNING AND EVALUATION OF PARK SUPPORT SYSTEMS (3)
- 435. RECREATION FACILITY PLANNING AND MAINTENANCE MANAGEMENT (3)
- 450. RECREATION ISSUES (1)
- 460. LEGAL ASPECTS OF RECREATION AND PARKS (3)
- 462. (SOC. 462) THE SOCIOLOGY OF LEISURE (3)
- 465. ADMINISTRATION OF RECREATION AND PARKS (3)
- 470. PARK MANAGEMENT (3)
- 477. THERAPEUTIC RECREATION SERVICES (3)
- 495. PRACTICUM (10)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 500. (Ph.Ed. 500) INDIVIDUAL STUDY AND RESEARCH PROJECTS (1-10) Prerequisite: Rc.Pk. 530.
- 515. PROGRAM DEVELOPMENT AND SUPERVISION (3) Critical analysis of the individual, political, and societal determinants of recreation programming; demonstration projects; evaluative procedures, research functions in programming. Prerequisite: Rc.Pk. 256.
- 522. SEMINAR IN CURRICULUM, ADMINISTRATION, AND EVALUATION OF ENVIRONMENTAL EDUCATION PROGRAMS (3)
- 525. BEHAVIORAL PATTERNS OF THE OUTDOOR RECREATIONIST (3) Patterns of time and space use; user characteristics; meaning of participation; facilitation of environment-use enhancement. Prerequisite: Rc.Pk. 320.
- 530. (Hl.Ed. 530, Ph.Ed. 530) RESEARCH TECHNIQUES IN HEALTH AND PHYSICAL EDUCATION AND RECREATION (3) Research techniques, including methods, research design, techniques for data collection, as applied to relevant problems in the health education field.
- 533. RECREATION STUDIES, SURVEYS, AND APPRAISALS (3) Advanced research procedures related to special recreation and park problems. Prerequisites: Rc.Pk. 530 and 3 credits in statistics.
- 540. PUBLIC AND PRIVATE RECREATION LANDS AND WATERS (3) Public and private roles and interactions, allocation of resources, use policies, open space concepts, private enterprise developments, legal controls.
- 550. SEMINAR IN RECREATION AND PARKS (1-6)



560. **ADMINISTRATIVE PROBLEMS OF RECREATION AND PARKS (3)** Special problems of recreation and park departments; legal powers and liability; departmental organization, financing, personnel policies, and staff development. Prerequisite: Rc.Pk. 465.

570. **CONCEPTUAL BASES FOR THERAPEUTIC RECREATION (3)** Issues in the application of concepts in therapeutic reaction from a multidisciplinary perspective; evaluation and research. Prerequisite: Rc.Pk. 477.

590. **COLLOQUIUM (1-3)**

595. **PHILOSOPHICAL AND SOCIAL BASES OF RECREATION (3)** Philosophical and social bases of recreation; analysis of critical issues of recreation for philosophical and social implications.

596. **INDIVIDUAL STUDIES (1-9)**

597. **SPECIAL TOPICS (1-9)**

## REGIONAL PLANNING (R PL)

HAYS B. GAMBLE, *Chairman of the Graduate Program in Regional Planning*  
213 Willard Building  
814-865-8333

**Degree Conferred:** M.R.P.

### Senior Members of the Graduate Faculty

Roger M. Downs, Ph.D. (Bristol) *Professor of Geography*  
Hays B. Gamble, Ph.D. (Penn State) *Professor of Agricultural Economics*  
Robert D. Lee, Jr., Ph.D. (Syracuse) *Professor of Public Administration*  
Stuart H. Mann, Ph.D. (Case Western Reserve) *Professor of Operations Research*  
Joe E. Miller, Ph.D. (Michigan State) *Associate Professor of Community Development*  
Monroe Newman, Ph.D. (Illinois) *Professor of Economics*  
Robert D. Pashek, Ph.D. (Illinois) *Professor of Business Administration*  
David L. Young, M.L.A. (Harvard) *Professor of Landscape Architecture*

### Associate Members of the Graduate Faculty

David N. Allen, Ph.D. (Indiana) *Assistant Professor of Public Administration*  
Daniel R. Jones, M.L.A. (Harvard) *Associate Professor of Landscape Architecture*  
Stanford M. Lembeck, Ph.D. (Penn State) *Assistant Professor of Rural Sociology Extension*  
Philippos John Loukissas, Ph.D. (Cornell) *Assistant Professor of Urban and Regional Planning*  
Barry L. Myers, J. D. (Boston Law) *Assistant Professor of Business Law*

The graduate program in Regional Planning emphasizes a multidisciplinary approach to the planning process for multijurisdictional areas, both urban and rural. The program's basic intent is to develop technically competent regional planners who are aware of the social, political, economic, and physical purposes of planning. A strong feature of the program is that it provides a broad opportunity for a student to pursue a sequence of courses in a special option or to earn a concurrent degree in a planning-related discipline. A nonthesis option is available for the M.R.P. degree. Graduates of the program are employed in planning agencies in all levels of government and in private industry.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Applicants must submit scores on the Graduate Record Examination with their applications. Students with a 3.00 junior-senior average and with appropriate course backgrounds will be admitted up to the number of spaces available. Exceptions to the 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

Applicants may receive advanced standing for work experience in the planning field and for approved prior course work in the areas of economics, geography, public administration, and statistics.

## RURAL SOCIOLOGY

### Student Aids

Graduate assistantships that may be available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

### REGIONAL PLANNING (R PL)

\*400. PRINCIPLES OF REGIONAL PLANNING (3-6)

410. PLANNING PROGRAMS (3)

\*440. PROBLEMS IN COMMUNITY AND REGIONAL PLANNING (1-9)

\*500. (P.Adm. 503) RESEARCH METHODS (1-3) Examination of research methodologies relevant to administration, planning, and public policy. Prerequisite: 3 credits of statistics.

502. REGIONAL SYSTEMS ANALYSIS (3-6) Spatial structure of regional and interregional systems; theories of regional development; spatial measures of location, density, central tendency, and dispersion.

503. THEORY AND METHOD OF PLANNING (3) Analysis of normative models of planning processes: social, economic, political, and behavioral assumptions, and methodological problems of evaluatory planning performance.

510. PLANNING TECHNIQUES AND ANALYSIS I (3) Regional socioeconomic structure, problems, and factors in planning; data collection, analysis, and implications.

520. PLANNING TECHNIQUES AND ANALYSIS II (3) Interaction of man and environment; land and water resources in regional planning; environmental factors as planning parameters.

530. PLANNING TECHNIQUES AND ANALYSIS III (3) Effects of political, cultural, and physical factors on planning.

531. PLANNING AND THE LAW (3) Sources of legal power, its transfer among governmental units; nature of regulatory power and legal constraints upon planning decision making.

540. PROBLEMS IN REGIONAL PLANNING (1-9) Planned individual projects involving library, laboratory (studio), or field work.

590. COLLOQUIUM (1-3)

595. PLANNING INTERNSHIP (1-6) Internship with a planning agency, under supervision of a graduate faculty member. Prerequisite: approval of program chairman.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

## RURAL SOCIOLOGY (R SOC)

JOHN W. MALONE, JR., *Head of the Department of Agricultural Economics and Rural Sociology*  
6 Weaver Building  
814-865-5461

**Degrees Conferred:** Ph.D., M.S., M.Agr.

### Senior Members of the Graduate Faculty

Robert C. Bealer, Ph.D. (Michigan State) *Professor of Rural Sociology*

Emory J. Brown, Ph.D. (Michigan State) *Professor of Rural Sociology*

Charles O. Crawford, Ph.D. (Cornell) *Professor of Rural Sociology*

John W. Malone, Jr., Ph.D. (Oklahoma State) *Professor of Agricultural Economics*

C. Shannon Stokes, Ph.D. (Kentucky) *Professor of Rural Sociology*

Rex H. Warland, Ph.D. (Iowa State) *Professor of Rural Sociology*

Kenneth P. Wilkinson, Ph.D. (Mississippi State) *Professor of Rural Sociology*

Fern K. Willits, Ph.D. (Penn State) *Professor of Rural Sociology*

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\*Offered at Capitol Campus only.



**Associate Members of the Graduate Faculty**

Donald M. Crider, Ph.D. (Penn State) *Associate Professor of Rural Sociology*  
 Daryl K. Heasley, Ph.D. (Penn State) *Associate Professor of Rural Sociology Extension*  
 Samuel M. Leadley, Ph.D. (Cornell) *Associate Professor of Rural Sociology*  
 Dan E. Moore, Ph.D. (Wisconsin) *Associate Professor of Rural Sociology*  
 Carolyn E. Sachs, Ph.D. (Kentucky) *Assistant Professor of Rural Sociology*  
 Joan Thomson, Ph.D. (Wisconsin) *Assistant Professor of Rural Sociology Extension*

All degree programs emphasize a comprehensive understanding of the various facets of societal organization pertinent to the rural sector. While scope is encouraged, areas of special interest and research include food choice, instigated social change, community structure, leadership, population, rural health, rural community services, the structure of agriculture, and the ecology of rurality in industrialized and urbanized society.

**Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Prerequisites for the master's program include 3 credits in rural sociology, 3 credits in sociology, and 3 additional credits in either field. If the entering student does not have these prerequisites, they must be made up at the University during the early part of the master's program.

Students with a 2.75 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.75 grade-point average may be made for students with special backgrounds, abilities, and interests.

**Degree Requirements**

All students are required to have training in sociological theory, statistics, and research methods.

There is no foreign language requirement for the Ph.D. degree; the student is expected to substitute such courses and instruction necessary to generate superior capabilities of inquiry into an analysis of basic and/or applied rural sociological problems.

**Student Aids**

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

**RURAL SOCIOLOGY (R SOC)**

- 402. CONSUMER BEHAVIOR AND AGRICULTURAL BUSINESS (3) *Herrmann*
- 425. POVERTY ANALYSIS: PEOPLE AND PROGRAMS (3) *Van Horn*
- 444. SOCIAL CHANGE IN RURAL AMERICA (3) *Sachs*
- 452. RURAL ORGANIZATION (3) *Wilkinson*
- 459. RURAL SOCIAL PSYCHOLOGY (3) *Willits*
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

501. DEVELOPMENT OF RURAL SOCIOLOGY (2) Historical development with emphasis on American rural sociology. Odd years. *Crider*

502. USE OF THEORY IN RURAL SOCIOLOGY (3) Examine and evaluate metasociology of alternative theoretical systems applicable to rural society, with emphasis on American society. Prerequisites: 24 credits in sociology, including 6 in rural sociology and 3 in sociological theory. Odd years. *Bealer*

505. LEADERSHIP DEVELOPMENT (3) Exploration, understanding, and application of leadership roles, strategies, and principles in group and community settings. Prerequisites: R.Soc. 305; 6 credits in social or behavioral sciences. *Heasley*

510. RURAL MIGRATION (2) Rural migration research and theory; application to governmental and community problems. Odd years. *Stokes*

## SCHOOL PSYCHOLOGY

513. **SOCIOLOGY OF CONSUMER BEHAVIOR (2)** Sociological theory and research pertaining to consumer behavior. Odd years. *Warland*
514. **VALUES IN RURAL SOCIETY (3)** Relevance for policy issues of persisting cultural and value differences between rural and urban sectors of American society. Prerequisites: R.Soc. 11, 444; 6 additional credits in rural sociology. Odd years. *Bealer*
515. (Ext.Ed. 515) **THE COOPERATIVE EXTENSION ORGANIZATION (3)** The Cooperative Extension Service as a social system, with emphasis on techniques of organization and program development. Prerequisites: 9 credits in education, communication, and/or social sciences. *Thomson*
516. **CHANGE IN RURAL SOCIETY (2)** Social change in rural society, emphasizing prediction and control of the change process. Even years. *Wilkinson*
517. **INTERNATIONAL RURAL SOCIAL CHANGE (3)** Implications of planned change for international rural societies, considering basic structural constraints, known institutional linkages, and potential synergetic consequences. Odd years. *Crider*
551. **RURAL SOCIOLOGY SEMINAR (1-6)** Prerequisites: 6 credits in rural sociology, sociology, or psychology.
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**
602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)**

## SCHOOL PSYCHOLOGY (S PSY)

JOSEPH L. FRENCH, *Professor-in-charge of the Graduate Program in School Psychology*  
104 Cedar Building  
814-865-1881

**Degrees Conferred:** D.Ed., M.S., M.Ed.

### Senior Members of the Graduate Faculty

Francis J. Di Vesta, Ph.D. (Cornell) *Professor of Education and Psychology*  
Joseph L. French, Ed.D. (Nebraska) *Professor of Special Education and Educational Psychology*  
Leon Gorlow, Ph.D. (Columbia) *Professor of Psychology*  
John J. Horan, Ph.D. (Michigan State) *Professor of Education*  
Donald B. Keat II, Ph.D. (Temple) *Professor of Education*  
John A. Salvia, D.Ed. (Penn State) *Professor of Special Education*  
Paul D. Weener, Ph.D. (Michigan) *Associate Professor of Educational Psychology*

### Associate Members of the Graduate Faculty

Asa Berlin, Ph.D. (Northwestern) *Professor of Speech Pathology*  
Linda W. Craighead, Ph.D. (Penn State) *Assistant Professor of Education*  
Robert L. Hale, Ph.D. (Nebraska) *Assistant Professor of Education*  
Joseph O. Prewitt-Díaz, Ph.D. (Connecticut) *Assistant Professor of Education*  
Helen I. Snyder, Ph.D. (Illinois) *Associate Professor of Educational Psychology*

This intercollege program is based primarily on courses in educational psychology, psychology, and special education. In addition, courses are often drawn from counselor education, individual and family studies, educational theory and policy, educational administration, and curriculum and instruction. The objective is to develop a psychologist who is interested in and knowledgeable about education and psychology in the school setting. The school psychologist must utilize professional skill and knowledge about children and youth to make contributions which are meaningful to, and utilized by, teachers, other school personnel, and parents. The development of competencies needed by a fully qualified school psychologist requires at least the education represented by a doctoral degree.

Practicum facilities, in addition to those in nearby public schools, include the Center for Educational Diagnosis and Remediation, the School Psychology Clinic, the Speech Pathology and Audiology Clinic, the Reading Center, and the Psychology Clinic. Facilities for work with children are also available through other academic units, as well as through assistantship assignments.



### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Only those students who anticipate a doctoral degree will be admitted. Students are selected within the limitations of program facilities. Priority is given to applicants with work experience with children.

An undergraduate major emphasizing work in psychology and/or education is preferred, but students with fewer than 20 upper-division credits in psychology, educational psychology, or special education may be admitted with limited deficiencies to be fulfilled concurrently with their graduate work. Requirements for admission include a minimum of one-third of graduate credits of A quality; satisfactory recommendations from two or more professors, preferably psychologists; and 500 or higher on the general sections of the Graduate Record Examination, 58 or higher on the Miller Analogies Test, and/or 35 or higher on the Quantitative Evaluative Device. Exceptions may be made for students with special backgrounds, abilities, and interests.

### Master's Degree Requirements

Students entering the program with a bachelor's degree complete the M.S. as prescribed by the Graduate School. Students qualifying for a certificate to practice in the schools must have a master's degree, about 60 graduate credits, and a practicum as described in our packet for prospective students.

### Doctoral Degree Requirements

Students may be admitted with a master's degree from school psychology programs from other institutions or from related programs in this or other universities. The doctoral program includes a predissertation research requirement, which may be satisfied with a master's thesis; the core program described below (which qualifies the candidate for a school psychology certificate); a special proficiency of 9 to 15 credits; an internship; and a dissertation.

Students completing the School Psychology Core Program will have courses in the biological bases of behavior, the cognitive bases of behavior, the social bases of behavior, personality theory or abnormal psychology, human development, professional ethics and standards, research design and methodology, statistics, psychometrics, counseling theory, educational foundations, educational administration, the education of exceptional children, and curriculum.

### Other Relevant Information

The professor-in-charge of the major serves as each student's academic and professional adviser at least through the first year of study. Each member of the faculty listed above may serve as an adviser for research.

The program has been accredited by the American Psychological Association, the National Commission for Accreditation in Teacher Education, and the Pennsylvania Department of Education.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## SCHOOL PSYCHOLOGY (S PSY)

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

500. PROFESSIONAL ISSUES IN SCHOOL PSYCHOLOGY (1-3) Orientation to the field through study of unique problems, current issues, ethical and legal matters, unique cases, and research projects.

504. PRACTICUM IN SCHOOL PSYCHOLOGY (1-6) Clinical experience with children under supervision in a variety of settings requiring service, including practice in synthesizing data and observations.

508. INTERNSHIP IN SCHOOL PSYCHOLOGY (1-10) Long-term placement in settings providing work for school psychologists with children, parents, teachers, administrators, and service agencies, under supervision.

## SOCIOLOGY

510. SUPERVISION OF SCHOOL PSYCHOLOGISTS (1-10) Program supervision and professional leadership in university clinics and school systems. Prerequisite: S.Psy. 504.

554. PSYCHOLOGICAL AND EDUCATIONAL EVALUATION OF EXCEPTIONAL CHILDREN (3) Administration and interpretation of individual tests other than the Stanford-Binet, WISC, WAIS. Prerequisite: S.Psy (Psy.) 559.

556. PSYCHOLOGICAL ASSESSMENT OF PRESCHOOL AND SCHOOL-AGED CHILDREN (2) Study of cognitive/affective tests; use of systems — analytic, multivariate statistical, actuarial methods of data combination in decision-making processes. Prerequisites: Ed.Psy. 400, 450; Ed.Psy. 554 or S.Psy (Psy.) 559.

559. (Psy. 559) THE INDIVIDUAL PSYCHOLOGICAL EXAMINATION (3) Demonstrations and practice in widely used ability and aptitude tests; psychological report writing. Prerequisites: 15 credits in psychology and a course in measurement.

596. INDIVIDUAL STUDIES (1-9)

## SOCIOLOGY (SOC)

ROLAND J. PELLEGRIN, *Head of the Department*  
201B Liberal Arts Tower  
814-865-0172

**Degrees Conferred:** Ph.D., M.A.

### Senior Members of the Graduate Faculty

Richard J. Bord, Ph.D. (Iowa) *Associate Professor of Sociology*  
Frank Clemente, Ph.D. (Tennessee) *Professor of Sociology*  
Clifford C. Clogg, Ph.D. (Chicago) *Associate Professor of Sociology and Statistics*  
Gordon F. De Jong, Ph.D. (Kentucky) *Professor of Sociology*  
Joseph E. Faulkner, Ph.D. (Penn State) *Associate Professor of Sociology*  
Craig R. Humphrey, Ph.D. (Brown) *Associate Professor of Sociology*  
Roland J. Pellegrin, Ph.D. (North Carolina) *Professor of Sociology*  
Francis M. Sim, Ph.D. (Michigan State) *Associate Professor of Sociology*  
Eloise C. Snyder, Ph.D. (Penn State) *Professor of Sociology*  
Darrell J. Steffensmeier, Ph.D. (Iowa) *Associate Professor of Sociology*  
Yoshimitsu Takei, Ph.D. (California) *Associate Professor of Education and Sociology*  
George A. Theodorson, Ph.D. (Cornell) *Professor of Sociology*  
David L. Westby, Ph.D. (Michigan State) *Associate Professor of Sociology*

### Associate Members of the Graduate Faculty

Roy L. Austin, Ph.D. (Washington) *Assistant Professor of Sociology*  
Sheldon R. Gelman, Ph.D. (Brandeis) *Professor of Social Welfare*  
Michael P. Johnson, Ph.D. (Michigan) *Assistant Professor of Sociology*  
John H. Kramer, Ph.D. (Iowa) *Associate Professor of Criminal Justice and Sociology*  
Daniel T. Lichter, Ph.D. (Wisconsin) *Assistant Professor of Sociology*  
Emilia E. Martinez-Brawley, D.Ed. (Temple) *Associate Professor of Social Welfare*  
Steven J. Stack, Ph.D. (Connecticut) *Associate Professor of Sociology*  
Marylee C. Taylor, Ph.D. (Harvard) *Assistant Professor of Sociology*  
Edward J. Walsh, Ph.D. (Michigan) *Associate Professor of Sociology*  
E. Mark Warr, Ph.D. (Arizona) *Assistant Professor of Sociology*

The graduate program in Sociology offers advanced education for students interested in academic and nonacademic careers in sociology.

The M.A. and Ph.D. programs center on training in basic social theory and methodology/statistics and the empirical findings in the various areas of sociology. Major graduate programs are offered in demography, social ecology and environmental sociology, large-scale social organizations, deviance and criminology, and social psychology. In addition, faculty research and teaching interest areas include gerontology, family, and race relations. Some course work outside the department is expected. Applied master's programs are offered in demography and in quantitative analysis.

All first-year students who intend to pursue doctoral work are expected to earn an M.A. degree in their normal progress to the Ph.D.

Other areas of study related to sociology, such as rural sociology, community development, cul-



tural anthropology, developmental psychology, and political behavior, are offered in other departments of the University.

Special department-related research and training facilities include the Liberal Arts Data Laboratory, small groups research laboratory, and the Population Issues Research Center. Additional University facilities used by sociology faculty and graduate students include the Computation Center, the Inter-University Consortium of Political and Social Research, the Institute for Policy Research Evaluation, and the Gerontology Center.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Undergraduate training in sociology is expected. Students of ability who are deficient in undergraduate preparation may be accepted with provisions to make up course deficiencies in the early part of their graduate program. Candidate selection is based on the following information: quality undergraduate academic performance; above-average Graduate Record Examination scores; letters of recommendation; an essay giving the applicant's interests, goals, and purposes for graduate work in sociology; and submission of written work from the student's undergraduate program, such as a term paper. Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

The population issues program is a course of study focusing on the social, economic, and geographic policy-related issues arising from the dynamics of population trends, especially in developed nations. In addition to departmental admission requirements, the population issues committee evaluates the student's interest and aptitude for the training program, which consists of a minimum of 18 credits of interdisciplinary course work in population.

### Degree Requirements

The department offers two options leading to the M.A. For the M.A. preparatory to the Ph.D., students must write a thesis and pass a candidacy examination. For the nonthesis M.A., students must submit a professional paper approved by a committee of three faculty members. Specified courses for the M.A. include one seminar each in research methods, social theory, and social statistics.

For the Ph.D. one additional specified seminar in social theory and one in social statistics are required. A candidacy examination is required of all students seeking the Ph.D. This evaluation by the department graduate faculty is based on the student's seminar papers, research proposal, and course performance.

The Department of Sociology has no formal foreign language or communication requirement. However, the student, working with his or her doctoral committee, is encouraged to pursue additional training in statistics, computer science, foreign language, technical writing, specialized methods, or specialized theory which will further dissertation and career plans.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following award typically has been available to graduate students in this program:

NATIONAL INSTITUTE OF AGING TRAINEESHIPS — Available to doctoral students in selected graduate programs for research training in adult development and aging; stipend varies. Details available from the Gerontology Center, S-211 Henderson Human Development Building.

### SOCIOLOGY (SOC)

- 400. ADVANCED GENERAL SOCIOLOGY (3)
- 401. SOCIAL INSTITUTIONS (3)
- 403. ADVANCED SOCIAL PSYCHOLOGY (3)
- 404. SOCIAL INFLUENCE AND SMALL GROUPS (3)
- 405. SOCIOLOGICAL THEORY (3)

## SOCIOLOGY

406. SOCIOLOGY OF DEVIANCE (3)
408. URBAN ECOLOGY (3)
409. (Soc.W. 409) RACIAL AND ETHNIC INEQUALITY IN AMERICA (3)
412. CRIME, SOCIAL CONTROL, AND THE LEGAL SYSTEM (3)
414. CRIMINAL CAREERS AND THE ORGANIZATION OF CRIME (3)
416. (Ed.Th.P. 416) SOCIOLOGY OF EDUCATION (3)
417. LAW AND SOCIETY (3)
423. SOCIAL DEMOGRAPHY (3)
424. SOCIAL CHANGE (3)
429. SOCIAL STRATIFICATION (3)
430. FAMILY IN CROSS-CULTURAL PERSPECTIVE (3)
432. SOCIAL MOVEMENTS (3)
435. SOCIAL GERONTOLOGY (3)
436. POLLING AND PUBLIC OPINION (4)
444. COMPLEX ORGANIZATIONS (3)
446. POLITICAL SOCIOLOGY (3)
447. (M.E.R. 447) ENVIRONMENT, ENERGY, AND SOCIETY (3)
450. COMMUNITY ORGANIZATION (3)
453. (Anthy. 453) PRIMITIVE RELIGION (3)
454. THE CITY IN POSTINDUSTRIAL SOCIETY (3)
455. WORK AND OCCUPATIONS (3)
461. SOCIOLOGY OF RELIGION (3)
462. (Rc.Pk. 462) THE SOCIOLOGY OF LEISURE (3)
470. INTERMEDIATE SOCIAL STATISTICS (4)
471. QUALITATIVE RESEARCH METHODS IN SOCIOLOGY (3)
473. METHODS FOR DEMOGRAPHIC ANALYSIS (3)
496. INDEPENDENT STUDIES (1-18)
497. SPECIAL TOPICS (1-9)
499. FOREIGN STUDY — SOCIOLOGY (2-6)
  
500. INTRODUCTION TO GRADUATE STUDY IN SOCIOLOGY (1) Required of all incoming graduate students in Sociology.
501. PROSEMINAR IN LARGE-SCALE SOCIAL ORGANIZATION (3) Perspectives on large-scale social organization, emphasizing the division of labor in stratification, formal organizations, politics, work, economy, and education.
502. THEORIES OF SOCIETY I (3) Review and analysis of trends and controversies in sociological theory from late eighteenth-century beginnings through the nineteenth century.
503. THEORIES OF SOCIETY II (3) Review and analysis of trends and controversies in sociological theory in the twentieth century.
504. ISSUES IN SOCIOLOGICAL THEORY (3) Seminar in the sociology of sociology, sociology of knowledge, and the philosophy of science, focused on current theory and methodology.
505. CONTEMPORARY SOCIOLOGICAL THEORY (3) Comparative evaluation of major theoretical perspectives in sociology today; critical analysis of current trends; examination of crucial contemporary problems.
511. RESEARCH METHODS IN CRIMINOLOGY AND DEVIANCE (3) Review of methodological issues; design and conduct of research; analysis and interpretation of findings; ethical and policy issues.
512. SEMINAR IN DEVIANT BEHAVIOR (3) Survey of theoretical and substantive issues in deviance and criminology, with emphasis on critical review of theories.
513. SOCIOLOGICAL RESEARCH METHODS (3) Critical review of methodological issues; research designs; analysis and interpretation of findings.
514. INSTRUMENTATION AND DATA COLLECTION IN SOCIAL RESEARCH (3) Chief techniques for collecting data in social research: interviews and questionnaires, laboratory and field observation, unobtrusive measures. Prerequisite: Soc. 513 or equivalent course in research methods.
523. POPULATION THEORY AND POLICY (3) Multidisciplinary population theory and research in developed and developing nations; relationships with contemporary population policy issues. Prerequisite: Soc. 423 or prior work in population or human ecology.



535. SOCIOLOGY OF AGING (3) Current research and methodological issues in the sociological study of aging.
544. CURRENT ISSUES IN COMPLEX ORGANIZATIONS (3) Critical survey of recent developments in sociological study of organizations and the theory of bureaucracy, including reciprocal effects on environments. Prerequisite: Soc. 444.
545. ECONOMY AND SOCIETY (3) Relationships between economic and societal factors: inequality, poverty, unemployment, crime, the family, and inflation.
546. SEMINAR IN POLITICAL SOCIOLOGY (3) Analysis of issues and problems in political sociology. Topical emphasis varies. Prerequisite: Soc. 446.
547. ENVIRONMENTAL SOCIOLOGY (3) The development of environmental sociology; research issues in the study of social organization, natural resources, and social change.
548. SOCIOLOGY OF ENERGY (3) Social aspects of energy production, conservation, and scarcity; interrelated problems in modern society.
551. SOCIAL STRATIFICATION AND SOCIAL CHANGE (3) Origin and development of stratification systems and inequality among and within societies; social mobility; change in stratification systems.
554. SMALL COMMUNITY POPULATION GROWTH, HUMAN ECOLOGY, AND SOCIAL CHANGE (3) Small-town population growth and ecology; images and realities of small-town life.
555. CURRENT RESEARCH IN WORK AND OCCUPATION (3) Topical seminar on nature and trends of research in the sociology of work, occupations, and professions.
573. MULTIVARIATE ANALYSIS IN SOCIAL RESEARCH (3) Overview of multivariate techniques in analysis of nonexperimental data; tabular analysis, multifactor analysis of variance, multiple correlation-regression. Prerequisite: 3 credits of statistics.
574. STATISTICAL METHODS FOR SOCIAL RESEARCH (3) Basic concepts of statistics; linear regression; computer software; analysis of social surveys; casual inferences from nonexperimental data. Prerequisites: 3 credits of statistics, 3 credits of research methods.
575. STATISTICAL MODELS FOR NONEXPERIMENTAL RESEARCH (3) Causal models for quantitative and qualitative data; path analysis and structural equations; log-linear and logit models; model building and specification. Prerequisite: Soc. 574.
576. APPLIED MATHEMATICAL DEMOGRAPHY (3) Survey of mathematical models used in the study of population: models of growth, survivorship, fertility, migration, stability, kinship, projection. Prerequisites: Soc. 473 or Anthy. 408; calculus.
583. RESEARCH SEMINAR IN SOCIAL PSYCHOLOGY (3) Design and conduct of research in areas of contemporary social psychology.
584. (Psy. 584) ATTITUDE FORMATION AND CHANGE (3) Theory and method in research on attitude formation and change with emphasis on critical analysis. Prerequisites: Soc. 403 or Psy. 417; 3 credits in statistics.
585. (Psy. 585) INTERACTION PROCESSES WITHIN AND BETWEEN GROUPS (3) Interactions in personal, group, and intergroup relations; theory and observational methods. Prerequisites: Soc. 403 or Psy. 417.
586. (Psy. 586) THE SOCIAL PSYCHOLOGY OF SOCIAL CHANGE (3) The interaction of individual, social, and cultural determinants of group and individual change; emphasis on social movements, crowds, and audiences. Prerequisites: Soc. 403 or Psy. 417.
587. (Psy. 587) SOCIALIZATION (3) Behavioral, cognitive, developmental, symbolic, interactionist, and role theories of socialization; emphasis on current theory and research. Prerequisites: Soc. 403 or Psy. 417.
588. (Psy. 588) THE SOCIAL ORGANIZATION OF ATTRIBUTION (3) Principles of attribution and their relevance to such topics as power relations, authority, equity, injustice, and social movements. Prerequisites: Soc. 403 or Psy. 417.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## SOLID STATE SCIENCE (S S S)

ROBERT E. NEWNHAM, *In Charge of Graduate Programs in Solid State Science*  
169 Materials Research Laboratory  
814-865-1612

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

S. Ashok, Ph.D. (Rensselaer Polytech.) *Assistant Professor of Engineering Science*  
Gerhard R. Barsch, Dr.rer.nat. (Göttingen) *Professor of Physics*  
James V. Biggers, Ph.D. (Penn State) *Senior Research Associate*  
George W. Brindley, Ph.D. (Leeds) *Professor Emeritus of Mineral Science*  
Leslie E. Cross, Ph.D. (Leeds) *Professor of Electrical Engineering*  
Mukunda B. Das, Ph.D. (London), D.I.C. *Professor of Electrical Engineering*  
Steven J. Fonash, Ph.D. (Pennsylvania) *Professor of Engineering Science*  
Earl K. Graham, Jr., Ph.D. (Penn State) *Professor of Geosciences*  
Heinz K. Henisch, Ph.D. (Reading) *Professor of Physics and of the History of Photography*  
Donald E. Kline, Ph.D. (Penn State) *Professor of Materials Science*  
Bruce E. Knox, Ph.D. (Penn State) *Associate Professor of Materials Science*  
Jeffrey S. Lannin, Ph.D. (Stanford) *Assistant Professor of Physics*  
Norman H. Macmillan, Ph.D. (Cambridge) *Assistant Professor of Solid State Science*  
A. Hamid Madjid, Dr.Sc.Nat. (Swiss Fed. Inst. of Tech.) *Associate Professor of Physics*  
Herbert A. McKinstry, Ph.D. (Penn State) *Associate Professor of Solid State Technology*  
Laxman N. Mulay, Ph.D. (Bombay) *Professor of Solid State Science*  
Robert E. Newnham, Ph.D. (Penn State, Cambridge) *Professor of Solid State Science*  
Della M. Roy, Ph.D. (Penn State) *Professor of Materials Science*  
Rustum Roy, Ph.D. (Penn State) *Evan Pugh Professor of the Solid State*  
Karl E. Spear II, Ph.D. (Kansas) *Professor of Ceramic Science*  
Vladimir Stubican, Dr. Phil. (Zagreb), D.Sc. *Professor of Ceramic Science*  
Kuppuswamy Vedam, Ph.D. (Indian Institute of Science) *Professor of Physics*  
Philip L. Walker, Jr., Ph.D. (Penn State) *Evan Pugh Professor of Materials Science*  
William B. White, Ph.D. (Penn State) *Professor of Geochemistry*

### Associate Members of the Graduate Faculty

Amar S. Bhalla, Ph.D. (Penn State) *Senior Research Associate*  
Michael W. Grutzeck, Ph.D. (Penn State) *Research Associate*  
Gerald G. Johnson, Jr., Ph.D. (Penn State) *Associate Professor of Computer Science*  
Russell F. Messier, Ph.D. (Penn State) *Senior Research Associate*  
Gary L. Messing, Ph.D. (Florida) *Assistant Professor of Ceramic Science and Engineering*  
Joseph R. Monkowski, Ph.D. (Penn State) *Associate Professor of Electrical Engineering*  
Robert N. Pangborn, Ph.D. (Rutgers) *Assistant Professor of Engineering Mechanics*  
Barry Earl Scheetz, Ph.D. (Penn State) *Associate Professor of Materials Research*  
Walter A. Schulze, Ph.D. (Penn State) *Senior Research Associate*

The aim of this intercollege program is to provide an opportunity for the student interested in the structure, properties, and behavior of solid materials to obtain an integrated program of courses encompassing both the necessary fundamentals of chemistry, physics, and mathematics and their technological and engineering applications.

The program of courses taken by a student majoring in this program must necessarily cut across two or more disciplines. The relevant subject matter has been grouped into four areas: (1) the structure of solids (crystal chemistry and structure determination); (2) theory related to the solid state (physics, chemistry, and mechanics); (3) properties of solids (optical, electrical, magnetic, mechanical, thermal, and chemical); and (4) reactions of solids (phase equilibria, reaction mechanisms, reaction kinetics, and surface reactions).

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*



Entering students should hold a bachelor's degree in chemistry, physics, mathematics, geological science, engineering, ceramics, or metallurgy, or in a closely related field that will have included in it mathematics at least through integral calculus and a minimum of one year of physics and one year of chemistry. Students with a 3.00 junior/senior grade-point average and with appropriate course backgrounds will be considered for admission. Exceptions to the 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. The applicant should be interested specifically in an interdisciplinary program of study and research.

### Degree Requirements

The course work of all students normally will include the "core program" as periodically redefined. Recommended course sequences for each year for students with different undergraduate backgrounds are prepared by the chairman and are available from the student's adviser.

S.S.S. 590 (Colloquium) and S.S.S. 596 (Individual Studies) will be offered several times each year to promote the interdisciplinary aspects of solid state science. Further information will be available from the solid state science office.

In addition, students may select appropriate course work from any engineering or science department. The following list includes those which are most commonly taken to satisfy core curriculum requirements: Structure of Solids: Mat.Sc. 408, 512, 514; Solid State Chemistry: Mat.Sc. 416, 501, 503; Solid State Physics: Phys. 412, 413, 524, and Cer.Sc. 508.

Thesis research on various aspects of the solid state may be conducted in the Materials Research Laboratory, the Applied Research Laboratory, or in appropriate departments in the Colleges of Earth and Mineral Sciences, Engineering, or Science. The experimental facilities for research in several aspects of materials science and engineering are exceptional.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of two foreign languages, or by one foreign language together with courses from other designated areas.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

AMERICAN CHEMICAL SOCIETY FELLOWSHIP — Available to a graduate student in solid state science; stipend \$6,204 plus tuition and fees.

AMERICAN CHEMICAL SOCIETY FELLOWSHIPS (2) — Open to graduate students in geochemistry, mineralogy, and solid state science; stipend \$2,400.

W. S. ELLIOTT FELLOWSHIP — Available to a graduate student who is a graduate of The Pennsylvania State University and is interested in engineering research; stipend variable. Apply to Office of the Dean, College of Engineering, 101 Hammond Building.

IBM FELLOWSHIP — Available to graduate students in solid state science; stipend \$5,400 plus tuition and fees.

INTERNATIONAL LEAD ZINC RESEARCH ORGANIZATION FELLOWSHIP — In support of research on the physics and chemistry of lead and zinc compounds. Available to a student in solid state science; stipend \$2,540.

RADIOACTIVE WASTE MANAGEMENT FELLOWSHIPS — Available to graduate students in Solid State Science, Nuclear Engineering, and the Geosciences for support in an M.S. degree program; stipend \$5,760 plus tuition and fees.

TAU BETA PI FELLOWSHIP — Open to any member of Tau Beta Pi, the engineering honor society, for a year of advanced study. Up to eighteen awards of \$3,500 each are available. Applications and information may be obtained from the Office of the Dean, College of Engineering, 101 Hammond Building. Application deadline is February 15.

### SOLID STATE SCIENCE (S S S)

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

## SPANISH (SPAN)

MARTIN S. STABB, *Head of the Department of Spanish, Italian, and Portuguese*  
N-352 Burrowes Building  
814-865-4252

**Degrees Conferred:** Ph.D., M.A., M.Ed.

### Senior Members of the Graduate Faculty

John B. Dalbor, Ph.D. (Michigan) *Professor of Spanish*  
Martha T. Halsey, Ph.D. (Ohio State) *Professor of Spanish*  
Robert F. Lima, Jr., Ph.D. (New York) *Professor of Spanish and Comparative Literature*  
Leon F. Lyday III, Ph.D. (North Carolina) *Professor of Spanish*  
Terry J. Peavler, Ph.D. (California) *Associate Professor of Spanish and Comparative Literature*  
Louis C. Pérez, Ph.D. (Michigan) *Professor of Spanish*  
Martin S. Stabb, Ph.D. (U.C.L.A.) *Professor of Spanish*  
H. Tracy Sturcken, Ph.D. (North Carolina) *Professor of Spanish*  
Alfred A. Triolo, Ph.D. (Illinois) *Associate Professor of Spanish and Italian*  
Beno Weiss, Ph.D. (New York) *Associate Professor of Italian*

### Associate Members of the Graduate Faculty

Earl E. Fitz, Ph.D. (C.U.N.Y.) *Assistant Professor of Portuguese, Spanish, and Comparative Literature*  
Carlos Zamora, Ph.D. (U.C.L.A.) *Assistant Professor of Spanish*

The program offers M.A. options in literature and linguistics, as well as doctoral emphasis in either of these two areas.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

The minimum requirement for admission normally will be 24 credits of postintermediate work in Spanish language and literature.

Students with a 3.00 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

### Degree Requirements

A candidate for the M.A. degree must take a minimum of 30 credits at the graduate level including 6 credits in a related minor field. An M.A. essay and a comprehensive written examination also are required.

The M.A. degree (or equivalent) is normally a prerequisite to doctoral candidacy.

For the Ph.D. degree, a student must complete at least 60 credits (including M.A. credits) of graduate-level work, including a 15-credit minor. Other requirements include (1) an oral doctoral candidacy examination and a comprehensive written examination; (2) a reading knowledge of two foreign languages or a comprehensive knowledge of one foreign language; and (3) a doctoral dissertation.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

EDWIN ERLE SPARKS DISSERTATION FELLOWSHIP IN THE HUMANITIES — Available to a doctoral candidate in one of the following graduate programs: classics, comparative literature, English, French, German, history, linguistics, philosophy, religious studies, Slavic languages and literatures, Spanish, and speech communication; stipend \$4,800 plus tuition. Apply to relevant department or program before February 1.



EDWIN ERLE SPARKS FELLOWSHIPS IN THE HUMANITIES (8) — Available to beginning graduate students in one of the following graduate programs; classics, comparative literature, English, French, German, history, linguistics, philosophy, religious studies, Slavic languages and literatures, Spanish, and speech communication; stipends \$3,800 plus tuition. Apply to relevant department or program before February 1.

## SPANISH (SPAN)

- 400. ADVANCED STYLISTICS (3)
- 410. ADVANCED ORAL EXPRESSION AND COMMUNICATION (3)
- 412. TRANSLATION (3)
- 414. SPANISH PHONOLOGY (3)
- 415. SPANISH MORPHOLOGY AND SYNTAX (3)
- 418. THE EVOLUTION OF SPANISH (3)
- 439. DON QUIJOTE (3)
- 440. (Fr. 440, It. 440) TEACHING OF ROMANCE LANGUAGES (3)
- 472. THE CONTEMPORARY SPANISH AMERICAN NOVEL (3)
- 476. MASTERPIECES OF SPANISH AMERICAN LITERATURE (3)
- 490. MASTERPIECES OF SPANISH PROSE (3)
- 491. MASTERPIECES OF SPANISH DRAMA AND POETRY (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
- 499. FOREIGN STUDY — SPANISH (3)
  
- 502. THEORY AND TECHNIQUES OF TEACHING SPANISH (1-3) Audio-lingual orientation.
- 503. METHODS AND BIBLIOGRAPHY IN SPANISH (1-3) Methods of research; evaluation of sources and materials.
- 507. HISPANO-ROMANCE LINGUISTICS (3 per semester, maximum of 9) History, development, and linguistic description of Old Spanish and related Romance languages of the Iberian Peninsula.
- 510. SPANISH DESCRIPTIVE LINGUISTICS: PHONOLOGY (3) *Dalbor*
- 511. SPANISH TRANSFORMATIONAL-GENERATIVE LINGUISTICS (3) *Dalbor*
- 514. HISPANIC DIALECTOLOGY (3 per semester, maximum of 6) Early fragmentation among the peninsular dialects; their status today, Judeo-Spanish; descriptive analysis of modern Spanish American dialects.
- 516. MEDIEVAL SPANISH LITERATURE (3 per semester, maximum of 9) Topics vary: *juglaría* and *clerecía*, emergence of lyric and brief narrative; history and didacticism; origins of novel; balladry; fifteenth-century innovations.
- 518. EL LIBRO DE BUEN AMOR (3) *Sturcken*
- 521. THE CELESTINA AND THE LITERATURE OF THE SPANISH PRE-RENAISSANCE (3) Chief trends and works of the period of the Catholic monarchs, with special emphasis on Fernando de Rojas's masterpiece *La Celestina*. *Pérez and Triolo*
- 526. SIXTEENTH-CENTURY SPANISH LITERATURE (3 per semester, maximum of 9) Prose and poetry of major authors; works and trends of the Renaissance and the early Golden Age. *Pérez and Triolo*.
- 528. SEVENTEENTH-CENTURY SPANISH LITERATURE (3 per semester, maximum of 9) Prose and poetry of major authors; works and trends of the late Golden Age and Baroque period. *Pérez and Triolo*
- 537. GOLDEN AGE THEATRE (3 per semester, maximum of 6) Major works of Lope de Vega, Tirso de Molina, Calderon, and others. *Pérez*
- 540. CERVANTES (3 per semester, maximum of 9) The literary works of Cervantes: *Don Quijote*, other novels, dramatic works, and poetry. *Pérez*
- 544. SPANISH ROMANTICISM (3) The major authors and works of peninsular romanticism, including poetry, drama, and prose. *Halsey and Lima*
- 550. SPANISH REALISM (3) The major figures of the period with special emphasis on Pérez Galdós. *Zamora*

## SPECIAL EDUCATION

553. WRITINGS OF THE "GENERATION OF 1898" (3 per semester, maximum of 6) Novels, plays short stories, essays, poetry of Valle-Inclán, Azorin, Benavente, Unamuno, Machado, Maeztu, and Baroja in the context of generation concept. *Lima*
560. THE CONTEMPORARY NOVEL IN SPAIN (3) The novel since 1941: Cela, Laforet, Zunzunegui, Suárez Carreño, Matute, and others. *Zamora*
563. CONTEMPORARY DRAMA IN SPAIN (3) The drama from 1898 to the present day: Benavente, Valle-Inclán, García Lorca, Casona, Buero Vallejo, Sastre, and others. *Halsey and Lima*
566. CONTEMPORARY SPANISH POETRY (3) Various currents in Spanish poetry from the generation of 1927: Lorca, Aleixandre, Salinas, Guillén, Alonso, Alberti, Hernández, Otero, and others. *Staff*
568. EARLY SPANISH AMERICAN LITERATURE (3 per semester, maximum of 9) Content varies; selected topics from colonial period, romanticism, and the nineteenth century before modernism. *Staff*
570. MODERNISMO (3) The movement, its antecedents, and its followers, with special emphasis on Rubén Darío. *Staff*
574. THE SPANISH AMERICAN NOVEL (3 per semester, maximum of 9) Content varies; selected works from the late nineteenth century through the contemporary period. *Peavler*
575. THE SPANISH AMERICAN ESSAY (3) Tracing the history of ideas in Spanish America through major essayists. *Stabb*
576. TWENTIETH-CENTURY SPANISH AMERICAN POETRY (3) Influential poets and literary movements after *Modernismo*. *Lyday and Stabb*
577. SPANISH AMERICAN DRAMA (3) Dramatic literature in Spanish America from colonial times to the present. *Lyday*
581. THE SPANISH AMERICAN SHORT STORY (3) Critical analysis of the major writers and movements from Echeverría to the present. *Lyday, Peavler, and Stabb*
587. STYLISTIC AND LITERARY CRITICISM (3) Major theories of literary criticism applied to Hispanic literature.
588. SEMINAR IN HISPANIC LITERATURE (3-12) Common and individual research in special problems in Spanish or Spanish American literature.

## SPECIAL EDUCATION (SPLED)

P. T. SINDELAR, *In Charge of Graduate Programs in Special Education*  
126 Moore Building  
814-863-2286

**Degrees Conferred:** Ph.D., M.S., M.Ed.

### Senior Members of the Graduate Faculty

Carol A. Cartwright, Ph.D. (Pittsburgh) *Professor of Education*  
G. Phillip Cartwright, Ph.D. (Pittsburgh) *Professor of Special Education*  
Joseph L. French, Ed.D. (Nebraska) *Professor of Special Education and Educational Psychology*  
John T. Neisworth, Ph.D. (Pittsburgh) *Professor of Special Education*  
John A. Salvia, D.Ed. (Penn State) *Professor of Special Education*  
Paul T. Sindelar, Ph.D. (Minnesota) *Assistant Professor of Special Education*  
James W. Tawney, Ph.D. (Illinois) *Professor of Special Education*

### Associate Members of the Graduate Faculty

John C. Abbott, Ph.D. (Penn State) *Associate Professor of Special Education*  
Anna H. Gajar, Ph.D. (Virginia) *Assistant Professor of Special Education*  
Libby Goodman, Ed.D. (Temple) *Associate Professor of Special Education*  
James W. Halle, Ph.D. (Kansas) *Assistant Professor of Special Education*  
Lester Mann, Ph.D. (North Carolina) *Professor of Special Education*  
James K. McAfee, Ph.D. (Georgia State) *Assistant Professor of Special Education*  
Marianne Price, Ed.D. (Temple) *Assistant Professor of Special Education*

Exceptional children are those who deviate so far from average in physical, intellectual, emotional, or social characteristics that they do not profit adequately from the usual public school program. It is



the purpose of the M.Ed. program in Special Education to prepare teachers of exceptional children. M.Ed. students are trained in behavior management and instructional design, implementation, and evaluation appropriate for effective work with mentally retarded, gifted, emotionally disturbed, and learning-disabled children at all age levels and degrees of severity. The purpose of the M.S. and Ph.D. programs is to prepare researchers and college and university teachers in areas encompassing the education of the mentally retarded, gifted, emotionally disturbed, or learning disabled. The former program is professional in nature; the latter two, academic.

### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Highest admission priorities are given to applicants who possess certification in special education or elementary education. Applicants for master's and doctoral programs must present evidence of superior academic achievement, complete a personal statement, present Graduate Record Examination (GRE) verbal and quantitative test scores, or Miller Analogies Test (MAT) scores, and provide professional references. Minimum test scores of master's and doctoral applicants, respectively, are GRE (verbal and quantitative combined), 900 and 1100; MAT, 35 and 50. Applicants for doctoral study must have had at least two years of relevant experience with handicapped children. Applicants from foreign countries must submit TOEFL (Test of English as a Foreign Language) scores. Exceptions to the admissions criteria may be made only for highly qualified students with special backgrounds, abilities, and interests.

### **Master's Degree Requirements**

Prerequisites for the M.Ed. program include 26 credits basic to the education of exceptional children (courses comparable to Spl.Ed. 400, 401, 454, and 395A, B, C, or D; Spl.Ed. 410, 430, or 470; Mth.Ed. 420, RCLEd. 400; a 400-level course in child development or child psychology; and a 400-level course in foundations of education). Of the 30 credits required for the M.Ed. degree, 6 must be taken from fields outside of education; 18 must be taken in special education; and 15 must be taken at the 500 level. Spl.Ed. 411, 412, and 573 are required along with two practica: Spl.Ed. 595A and 595B. M.Ed. students must submit a master's paper and pass a comprehensive examination.

Of the 30 credits required for the M.S. degree, 6 must be taken from one discipline outside of education; 18 must be taken in special education; and 18 must be taken at the 500 level. Spl.Ed. 573 and Ed.Psy. 400 are required as are 6 credits of thesis research, Spl.Ed. 600. M.S. students must submit a master's thesis and pass a comprehensive examination.

### **Doctoral Degree Requirements**

The communication and foreign language requirement for the Ph.D. degree may be satisfied by options selected from designated areas including, but not limited to, foreign languages. Minimum requirements for the Ph.D. degree include 24 credits of research methods; 18 credits in a cognate area such as psychology, sociology, or child development; and 36 credits in education. A candidacy examination is required no later than the second semester of full-time study; written and oral comprehensive examinations are required following the satisfactory completion of the language requirement.

### **Student Aids**

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following award typically has been available to graduate students in this program:

U.S. OFFICE OF EDUCATION TRAINEESHIPS IN SPECIAL EDUCATION — Open to graduate students being prepared as leadership personnel in special education; stipend \$300 per semester plus tuition. Graduate assistantships also available. Apply to the Graduate Admissions Committee, 118 Moore Building.

## SPECIAL EDUCATION (SPLED)

- 400. INTRODUCTION TO EXCEPTIONAL CHILDREN (3)
- 401. EDUCATIONAL ADJUSTMENTS FOR EXCEPTIONAL CHILDREN (3)
- 402. HUMAN RIGHTS FOR THE HANDICAPPED STUDENT (2)
- 404. PARENTS AS TEACHERS (2)
- 410. THE MENTALLY RETARDED (3)
- 411. INSTRUCTION FOR THE SEVERELY HANDICAPPED (3)
- 412. INSTRUCTION FOR THE MILDLY HANDICAPPED STUDENT (3)
- 413. (Voc.Ed. 413) VOCATIONAL EDUCATION FOR SPECIAL-NEEDS LEARNERS (3)
- 415. EARLY SPECIAL EDUCATION (3)
- 416. ASSESSING EXCEPTIONAL PRESCHOOLERS (1)
- 417. DEVELOPMENT OF INDIVIDUAL EDUCATION PROGRAMS (1)
- 418. TECHNOLOGY APPLICATIONS FOR HANDICAPPED PERSONS (2)
- 420. (Ed.Psy. 420) THE MENTALLY GIFTED (3)
- 430. LEARNING DISABILITIES (3)
- 440. (Cm.Dis. 440) SURVEY OF SPEECH AND HEARING DISORDERS (3)
- 454. DIAGNOSIS OF EDUCATIONAL DISABILITIES (3)
- 470. THE EMOTIONALLY DISTURBED (3)
- 495A. PRACTICUM IN GENERAL SPECIAL EDUCATION (1-12)
- 495B. PRACTICUM IN VOCATIONAL SPECIAL EDUCATION (1-12)
- 495C. PRACTICUM WITH YOUNG HANDICAPPED CHILDREN (1-12)
- 495D. PRACTICUM WITH SEVERELY HANDICAPPED CHILDREN (1-12)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
  
- 500. SEMINAR IN SPECIAL EDUCATION (1-9) Continuing series of professional seminars designed to provide a forum for discussion of current and classical research concerning exceptional children. Prerequisites: Ed.Psy. 400; 6 credits in special education.
- 501. ADMINISTRATION AND SUPERVISION OF EDUCATIONAL PROGRAMS FOR EXCEPTIONAL CHILDREN (2-3) Problems connected with the instituting and organizing of classes for atypical children; the legal phases, finances, teaching personnel, pupil personnel, housing, equipment, courses of study, curriculum, etc. Prerequisites: Spl.Ed. 401 and Ed.Adm. 480, or teaching or administrative or supervisory experience.
- 595A. PRACTICUM (1-6) Supervised clinical experience on campus in University-managed diagnostic and remedial settings.
- 595B. FIELD EXPERIENCES IN OFF-CAMPUS LABORATORIES (1-10) Supervised off-campus field experiences in selected laboratory settings with exceptional children. Prerequisite: Spl.Ed. 595A.
- 595C. INTERNSHIP IN SPECIAL EDUCATION SUPERVISION (1-6) Internship in day/residential school setting under supervision of field supervisor and University faculty. Prerequisite: Spl.Ed. 595B.
- 595D. INTERNSHIP IN SPECIAL EDUCATION (2-10) Internship to take place in schools or educational situations where student is not regularly employed, under supervision of graduate faculty. Prerequisite: Spl.Ed. 495A or 495B or 495C or 495D or teaching experience.
- 510. PROBLEMS IN THE EDUCATION OF THE MENTALLY RETARDED (2-4) Study of existing curriculums, instructional practices, educational programs; experimentation in curriculum building and materials construction. Prerequisites: teaching experience and Spl.Ed. 410.
- 520. PROBLEMS IN THE EDUCATION OF THE MENTALLY GIFTED (2-4) Analysis of educational needs of the mentally gifted; curriculum construction and curricular materials. Prerequisites: Spl.Ed. (Ed.Psy.) 420, teaching experience.
- 530. PROBLEMS IN THE EDUCATION OF THE LEARNING DISABLED (2-4) Review of the research and theoretical implications in the educational and behavioral management of learning disabled children. Prerequisite: Spl.Ed. 430.
- 547. (Cm.Dis. 547) LANGUAGE DISORDERS IN CHILDREN (2) Nature, etiology, diagnosis, and management of language disorders in children. Prerequisites: Cm.Dis. 400; 6 credits in communication disorders or related fields such as psychology, linguistics, or human development.



555. CURRICULUM-BASED ASSESSMENT FOR HANDICAPPED LEARNERS (2) Development and use of diagnostic procedures for planning and evaluating instructional programs for handicapped pupils. Prerequisites: Spl.Ed. 454; Spl.Ed. 105 or 400.

569. EDUCATING THE AUTISTIC CHILD (2) Behavioral characteristics, etiology, and treatment emphasizing attention, social interaction, discrimination, self-injurious and self-stimulatory behavior, and language. Prerequisites: Spl.Ed. 401, 470.

570. PROBLEMS IN THE EDUCATION OF THE EMOTIONALLY DISTURBED (2-4) Prerequisite: Spl.Ed. 470.

573. PROBLEMS OF RESEARCH WITH HANDICAPPED GROUPS (2) A seminar to review and design research studies for the education and training of handicapped groups. Prerequisite or concurrent: Spl.Ed. 454.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## SPEECH COMMUNICATION (SPCOM)

ROBERT S. BRUBAKER, *Head of the Department*  
212 Sparks Building  
814-865-3461

**Degrees Conferred:** Ph.D., M.A.

### Senior Members of the Graduate Faculty

Thomas W. Benson, Ph.D. (Cornell) *Professor of Speech Communication*  
Robert S. Brubaker, Ph.D. (Illinois) *Professor of Speech Communication*  
Herman Cohen, Ph.D. (Iowa) *Professor of Speech Communication*  
Harvey R. Gilbert, Ph.D. (Wisconsin) *Associate Professor of Speech Communication and Speech Science*  
Richard B. Gregg, Ph.D. (Pittsburgh) *Professor of Speech Communication*  
Gerard A. Hauser, Ph.D. (Wisconsin) *Associate Professor of Speech Communication*  
John V. Hinds, Ph.D. (S.U.N.Y.) *Associate Professor of Speech Communication*  
Stanley F. Paulson, Ph.D. (Minnesota) *Professor of Speech Communication*  
Gerald M. Phillips, Ph.D. (Case Western Reserve) *Professor of Speech Communication*  
Eugene E. White, Ph.D. (Louisiana State) *Professor of Speech Communication*

### Associate Members of the Graduate Faculty

Richard L. Barton, Ph.D. (Oregon) *Associate Professor of Speech Communication*  
David E. Butt, D.Ed. (Penn State) *Associate Professor of Speech Communication*  
Peter Christenson, Ph.D. (Stanford) *Assistant Professor of Speech Communication*  
Kathryn B. DeBoer, Ph.D. (Denver) *Associate Professor of Speech Communication*  
Robert E. Dunham, Ph.D. (Ohio State) *Professor of Speech Communication*  
Randy Y. Hirokawa, Ph.D. (Washington) *Assistant Professor of Speech Communication*  
Christopher L. Johnstone, Ph.D. (Wisconsin) *Associate Professor of Speech Communication*  
Tony M. Lentz, Ph.D. (Michigan) *Assistant Professor of Speech Communication*  
Thomas R. Lindlof, Ph.D. (Texas) *Assistant Professor of Speech Communication*  
Mary S. Mander, Ph.D. (Illinois) *Assistant Professor of Speech Communication*  
Douglas J. Pedersen, D.Ed. (Penn State) *Associate Professor of Speech Communication*  
William K. Rawlins, Ph.D. (Temple) *Assistant Professor of Speech Communication*  
Paul A. Zawadzki, Ph.D. (Iowa) *Assistant Professor of Speech Communication*

Students may specialize in communication theory, English as a second language, oral interpretation, organizational communication, rhetorical theory and criticism, small group and interpersonal communication, speech education, speech science, and telecommunication.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the*

*APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

The minimum undergraduate preparation is 12 credits in speech. Students who cannot meet this requirement in full may be admitted but must make up their deficiencies without credit toward the graduate degree.

Additionally, students with a 3.00 junior-senior average, scores from the Graduate Record Examination (general), and appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. Students must have completed the master's degree before being admitted as a doctoral candidate.

### **Master's Degree Requirements**

A total of 30 credits, including 6 for the thesis, is required for the M.A. in Speech Communication. A thesis is required of all M.A. candidates in this major. Sp.Com. 420 or 435 or 440 is required of all graduate students who do not have their equivalent. Master's candidates must schedule a review of their program of courses during their first year of residence. Master's candidates must schedule a proposal meeting at which the research plan for their thesis is approved by their committee. Master's candidates are required to present an oral defense of their thesis before their committee.

### **Doctoral Degree Requirements**

The communication and foreign language requirement for the Ph.D. degree may be satisfied by options selected from designated areas including, but not restricted to, foreign languages. Sp.Com. 420 or 435 or 440 is required of all graduate students who do not have their equivalent. Doctoral candidates must schedule a candidacy evaluation during their first year. Following completion of the language requirement, doctoral candidates must take a comprehensive examination to determine their mastery and competence in speech communication. Doctoral candidates must schedule a proposal meeting at which the research plan for their dissertation is approved by their committee. Doctoral candidates must present a final oral defense of their dissertation before their committee.

### **Student Aids**

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

**EDWIN ERLE SPARKS DISSERTATION FELLOWSHIP IN THE HUMANITIES** — Available to a doctoral candidate in one of the following graduate programs: classics, comparative literature, English, French, German, history, linguistics, philosophy, religious studies, Slavic languages and literatures, Spanish, and speech communication; stipend \$4,800 plus tuition. Apply to relevant department or program before February 1.

**EDWIN ERLE SPARKS FELLOWSHIPS IN THE HUMANITIES (8)** — Available to beginning graduate students in one of the following graduate programs: classics, comparative literature, English, French, German, history, linguistics, philosophy, religious studies, Slavic languages and literatures, Spanish, and speech communication; stipends \$3,800 plus tuition. Apply to relevant department or program before February 1.

## **SPEECH COMMUNICATION (SPCOM)**

\*115G. ENGLISH AS A SECOND LANGUAGE: SPEAKING AND LISTENING (3-9) English as a second language focusing on speaking and listening skills.

\*116G. ENGLISH AS A SECOND LANGUAGE: READING AND WRITING (3-9) English as a second language; for graduate students; focusing on reading and writing skills.

\*117G. ENGLISH AS A SECOND LANGUAGE FOR TEACHING ASSISTANTS (3-9) English as a second language for preparation of international teaching assistants.

400. SPEECH COMMUNICATION TRAINING IN BUSINESS (3)

401. TELECOMMUNICATIONS RESEARCH METHODS (3)

402. SPEECH AND HUMAN BEHAVIOR (3)

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\*No graduate credit is given for this course.



403. INTERPERSONAL ORAL COMMUNICATION THEORY (3)
410. AMERICAN-ENGLISH PHONETICS (3)
412. SPEECH CRITICISM (3)
413. (Ling. 413) EXPERIMENTAL LINGUISTICS (3)
414. SPEECH SCIENCE (3)
415. RHETORIC OF FILM AND TELEVISION (3)
419. (Journ. 419) INTERNATIONAL TELECOMMUNICATIONS (3)
420. SYSTEMS AND THEORIES OF RHETORIC (3)
431. ANATOMY AND PHYSIOLOGY OF THE VOCAL MECHANISM (3)
435. THEORIES AND ISSUES IN TELECOMMUNICATIONS (3)
437. TELEVISION PROGRAMMING AND PERFORMANCE (3)
440. SYSTEMS AND THEORIES OF HUMAN COMMUNICATION (3)
450. GROUP COMMUNICATION THEORY (3)
452. ORGANIZATIONAL COMMUNICATION (3)
455. GENDER ROLES IN COMMUNICATION (3)
460. FOUNDATIONS OF RHETORICAL THEORY (3)
470. NONVERBAL COMMUNICATION (3)
475. STUDIES IN PUBLIC PERSUASION (3)
478. CONTEMPORARY AMERICAN POLITICAL RHETORIC (3)
480. ORAL TRADITION OF INTERPRETATION (3)
481. (L.A. 481) COMPUTER APPLICATIONS TO COMMUNICATIONS STUDIES (3)
484. LINGUISTIC STRUCTURES FOR ENGLISH AS A SECOND LANGUAGE (3)
485. ADVANCED ORAL INTERPRETATION OF LITERATURE (3)
490. PSYCHOLOGY OF SPEAKING AND LISTENING (3)
491. THEORY: SECOND LANGUAGE ACQUISITION (3)
492. DEVELOPMENT OF COMMUNICATION BEHAVIOR IN CHILDREN (3)
493. TEACHING OF ENGLISH AS A SECOND LANGUAGE (3)
494. RESEARCH TOPICS (1-12)
495. COMMUNICATION INTERNSHIP (1-9)
496. INDEPENDENT STUDIES (1-18)
497. SPECIAL TOPICS (1-9)
499. (Journ. 499) FOREIGN STUDY — MASS COMMUNICATIONS (1-9)
  
500. SEMINAR IN HISTORICAL CRITICISM (2-6) Application of principles of rhetorical criticism to significant oral communications of the past.
502. COMMUNICATION THEORY AND RESEARCH (3) Research design, thesis proposals, and background for research in graduate study. Prerequisites: 6 credits at the 400 or 500 level in speech communication, clinical speech, or theatre arts.
503. SEMINAR IN CRITICISM (3 per semester, maximum of 6) Study of philosophies and methods available for the critical analysis of rhetorical transactions. Prerequisite: Sp.Com. 412.
505. HISTORICAL DEVELOPMENT OF RHETORICAL THEORY (3 per semester, maximum of 9) Study of one or more periods of rhetorical theory from Greek antiquity to 1900. Prerequisite: Sp.Com. 420.
506. HISTORICAL DEVELOPMENT OF SPEECH THEORY AND CRITICISM (2-4) Theories of speech making from the Renaissance to the present.
507. CONTEMPORARY RHETORICAL THEORY (2-4) A study of rhetorical theory from 1930 to the present, focusing on semantic, political, sociological, symbolic, and philosophical perspectives. Prerequisites: Sp.Com. 412, 505 and/or 506.
509. PROBLEMS IN RHETORIC AND COMMUNICATION (3-12) Theoretical, analytical, and critical problems of human communication, with application of humanistic and social scientific research framework. Prerequisites: 6 credits in speech communication.
510. PROBLEMS IN SPEECH EDUCATION (2-4) Advanced knowledge, theories, and principles, together with their philosophical, scientific, clinical, artistic, and educational implications for the teacher of speech. Prerequisites: Sp.Com. 502 and 9 additional credits at the 400 or 500 level in speech communication, clinical speech, or theatre arts.
515. SEMINAR IN RHETORIC AND MEDIA (3) Seminar in the application of rhetorical theory and criticism to special problems of communication in television, film, and other media.

## STATISTICS

520. SEMINAR IN SPEECH SCIENCE (3-6) Seminar in physical and physiological bases of speech and voice; introduction to laboratory techniques used in speech research. Prerequisites: 9 credits in speech communication, speech pathology and audiology, or psychology.
522. (Cm.Dis. 522) SPEECH PERCEPTION (3) Transformation of linguistic units into acoustic speech signals, theories of speech perception, and auditory processing of the speech signal. Prerequisites: Sp.Com. 410, 431, 520.
530. POLITICAL MEDIA (3) Study of research, theory, and selected cases of political communication in the broadcast media.
540. SEMINAR IN TELECOMMUNICATIONS (3) Study of the historical and contemporary issues and problems in telecommunications.
550. SEMINAR IN ORAL PERSUASION (2-4) Theory and devices of persuasion; analysis of persuasive discourse. Prerequisites: 6 credits in speech communication including Sp.Com. 100.
551. (Ling. 551) LINGUISTIC ANALYSIS OF A NON-INDO-EUROPEAN LANGUAGE (3) An investigation into the phonological, morphological, syntactic, and discourse structures of a selected non-Indo-European language. Prerequisite: Ling. 400 or 403 or Sp.Com. 484.
552. ORAL COMMUNICATION IN INDUSTRY, BUSINESS, AND GOVERNMENT (2-4) Needs, practices, and methods in American industry, business, and government; methods of training adults in oral communications skills.
554. SEMINAR IN SMALL GROUP COMMUNICATION (2-4) Communication variables in small groups. Experimental research and innovations in communication in vocational, therapeutic, and educational groups.
581. DISCOURSE ANALYSIS IN ESL (ENGLISH AS A SECOND LANGUAGE) (3) An inquiry into the role of context on the form and meaning of linguistic structures from an ESL perspective. Prerequisites: Sp.Com. 491, 493.
590. COLLOQUIUM (1-3)
591. SEMINAR IN SECOND LANGUAGE ACQUISITION (3) Advance research in theoretical and experimental issues in second language acquisition. Prerequisite: Sp.Com. 491.
593. RESEARCH PROBLEMS IN ENGLISH AS A SECOND LANGUAGE (3) A detailed investigation into specific areas of research in English as a second language. Prerequisite: Sp.Com. 493.
594. RESEARCH TOPICS (1-12) Supervised student activities on research projects identified on an individual or small group basis. Prerequisite: prior approval of proposed assignment by instructor.
595. INTERNSHIPS (1-9)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## STATISTICS (STAT)

WILLIAM L. HARKNESS, *Head of the Department*  
219 Pond Laboratory  
814-865-1348

**Degrees Conferred:** Ph.D., M.S., M.A.

### Senior Members of the Graduate Faculty

Charles E. Antle, Ph.D. (Oklahoma State) *Professor of Statistics*  
James B. Bartoo, Ph.D. (Iowa) *Professor of Mathematical Statistics*  
Frank A. Haight, Ph.D. (New Zealand) *Professor of Statistics and Transportation*  
William L. Harkness, Ph.D. (Michigan State) *Professor of Mathematical Statistics*  
Thomas P. Hettmansperger, Ph.D. (Iowa) *Professor of Statistics*  
Robert A. Hultquist, Ph.D. (Oklahoma State) *Professor of Statistics*  
Ganapati P. Patil, Ph.D., D.Sc. (Michigan) *Professor of Mathematical Statistics*  
Thomas A. Ryan, Jr., Ph.D. (Cornell) *Associate Professor of Statistics*



### Associate Members of the Graduate Faculty

Steven F. Arnold, Ph.D. (Stanford) *Associate Professor of Statistics*  
 Marilyn T. Boswell, Ph.D. (California, Riverside) *Assistant Professor of Statistics*  
 Clifford C. Clogg, Ph.D. (Chicago) *Associate Professor of Sociology and Statistics*  
 Bruce G. Lindsay, Ph.D. (Washington) *Assistant Professor of Statistics*  
 James D. Lynch, Ph.D. (Florida State) *Assistant Professor of Statistics*  
 James L. Rosenberger, Ph.D. (Cornell) *Associate Professor of Statistics*

Graduate instruction and research opportunities are available in most areas of statistics and probability, including linear models, nonparametric statistics, robustness, statistical computing, analysis of count data, multivariate analysis, experimental design, reliability, stochastic processes and probability (applied and theoretical), distribution theory, statistical ecology, and biometrics.

Graduate students can gain practical experience in the application of statistical methodology through participation in the department's statistical consulting and collaborative research activities. For course credit, students can participate in statistical consulting with researchers (graduate students, staff, and faculty) in other departments. In addition, collaborative projects with other departments provide longer term experience and support for selected students.

Most students gain valuable teaching experience by assisting in the teaching and grading of courses. In addition, Ph.D. candidates with proper qualifications can receive support for teaching undergraduate courses.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

While applications from all students (including those who already have done graduate work) are reviewed, completion of a standard calculus sequence is regarded as a prerequisite. Students with a 3.00 or better junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

Entering graduate students in statistics for whom English is not the first language are required to have a score of at least 550 on the TOEFL (Test of English as a Foreign Language) examination. The results of this examination must be received by the Department of Statistics at least six months prior to the requested date of admission to the Graduate School.

### Degree Requirements

For the M.A. degree the candidate must complete 30 course credits, with at least 18 credits (12 in statistics) of 500-level courses; 3 credits in probability (Stat. 414); 6 credits in mathematical statistics (Stat. 415, 416); 3 credits in computer science; Math. 441 or 436; 3 credits in seminars and/or individual studies; and 6 credits in an approved area. In addition, the M.A. candidate must submit a master's paper. The requirements for the M.S. degree are the same as for the M.A. except that 6 credits of thesis research replace an equal number of course credits, and a thesis is required rather than a master's paper.

The department administers a qualifying examination which each student must take after the first year. This written examination must be passed as a requirement for the master's degree, and in addition, superior performance on this examination is used by the department to recommend students for Ph.D. candidacy.

A written comprehensive examination, administered by the department, must be taken by each Ph.D. candidate after two or three years of course work. This is followed by an oral examination, as required by the Graduate School, under the supervision of the student's graduate committee. The oral examination typically coincides with initiation of the doctoral thesis research. After the thesis is written, the student and thesis adviser schedule the oral defense, the final examination for the Ph.D. degree. There is no foreign language requirement for the Ph.D. in Statistics.

## Other Relevant Information

Students in the Statistics program may elect the dual-title degree program option in Operations Research for the Ph.D. and M.S. degrees (see p. 285).

## Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## STATISTICS (STAT)

- 401. EXPERIMENTAL METHODS (3)
- 409. (Math. 409) MATHEMATICAL STATISTICS I (3)
- 410. (Math. 410) MATHEMATICAL STATISTICS II (3)
- 414. (Math. 414) INTRODUCTION TO PROBABILITY THEORY (3)
- 415. (Math. 415) INTRODUCTION TO MATHEMATICAL STATISTICS (4)
- 416. (Math. 416) STOCHASTIC MODELING (3)
- 418. DISCRETE PROBABILITY THEORY (3)
- 451. INTRODUCTION TO APPLIED STATISTICS (3)
- 460. INTERMEDIATE APPLIED STATISTICS (3)
- 462. APPLIED REGRESSION ANALYSIS (3)
- 464. APPLIED NONPARAMETRIC STATISTICS (3)
- 480. INTRODUCTION TO STATISTICAL PROGRAM PACKAGES (1)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

501. REGRESSION METHODS (3) Analysis of research data through simple and multiple regression and correlation; polynomial models; indicator variables; step-wise, piece-wise, and logistic regression. Prerequisites: 6 credits of statistics or Stat. 451; matrix algebra.

502. ANALYSIS OF VARIANCE AND DESIGN OF EXPERIMENTS (3) Analysis of variance and design concepts; factorial, nested, and unbalanced data; ANCOVA; blocked, Latin square, split-plot, repeated measures designs. Prerequisites: Stat. 462 or 501.

503. DESIGN OF EXPERIMENTS (3) Design principles; optimality; confounding in split plot, repeated measures, fractional factorial, response surface, and balanced/partially balanced incomplete block designs. Prerequisites: Stat. 502; Stat. 462 or 501.

504. ANALYSIS OF DISCRETE DATA (3) Models for frequency arrays; goodness-of-fit tests; two-, three-, and higher-way tables; latent and logistics models. Prerequisites: Stat. 460 or 502 or 516; matrix algebra.

505. APPLIED MULTIVARIATE STATISTICAL ANALYSIS (3) Analysis of multivariate data;  $T^2$ -tests; partial correlation; discrimination; MANOVA; cluster analysis; regression; growth curves; factor analysis; principal components; canonical correlations. Prerequisites: 6 credits in statistics; matrix algebra.

506. SAMPLING THEORY AND METHODS (3) Theory and application of sampling from finite populations. Prerequisites: calculus; 3 credits in statistics.

508. APPLIED STATISTICAL DISTRIBUTION THEORY (3) Analysis of data involving nonnormal families of distributions; model building and selection, parameterizations, inferential algorithms, transformations, simulations, displays, interpretations. Prerequisites: Stat. 401 or 409.

509. DISCRETE STATISTICAL MODELS AND METHODS (3) Systematic study of probability models and statistical methods pertaining to statistical analysis of data consisting of single and multiple counts. Prerequisites: Stat. 410, 548.

510. APPLIED TIME SERIES ANALYSIS (3) Identification of models for empirical data collected over time. Use of models in forecasting. Prerequisite: Stat. 462 or 501 or 511.

511. REGRESSION ANALYSIS AND MODELING (3) Multiple regression methodology using matrix notation; linear, polynomial, and nonlinear models; indicator variable; AOV models; piece-wise regression, autocorrelation; residual analyses. Prerequisite: Stat. 451 or 6 credits of statistics; matrix algebra, calculus.



512. DESIGN AND ANALYSIS OF EXPERIMENTS (3) AOV, unbalanced, nested factors; CRD, RCBD, Latin squares, split-plot, and repeated measures; incomplete block, fractional factorial, response surface designs; confounding. Prerequisite: Stat. 511.
516. (Math. 516) STOCHASTIC PROCESSES (3) Markov chains; generating functions; limit theorems; continuous time and renewal processes; martingales, submartingales, and supermartingales; diffusion processes; applications. Prerequisite: Stat. (Math.) 416.
- 517-518. (Math. 517) PROBABILITY THEORY (3 each) Measure theoretic foundation of probability, distribution functions and laws, types of convergence, central limit problem, conditional probability, special topics. Prerequisite: Math. 501.
519. (Math. 519) TOPICS IN STOCHASTIC PROCESSES (3) Selected topics in stochastic processes, including Markov and Wiener processes; stochastic integrals, optimization, and control; optimal filtering. Prerequisite: Stat. (Math.) 516, 517.
524. ECOMETRICS (3) Stochastic models and statistical methods in ecological problems; population dynamics, spatial patterns in populations of one, two, or more species. Prerequisite: Stat. (Math.) 409 or Stat. 418.
525. BIostatISTICS (3) Medical experimentation and epidemiological studies; retrospective and prospective studies; design of clinical trials; clinical trials; models for censored survival data. Prerequisites: Stat. 501 or 511.
527. (Biol. 527) QUANTITATIVE ECOLOGY (3) Introduction to quantitative population and community ecology with emphasis on problems, concepts, and methods using mathematical, statistical, and computational analysis. Prerequisites: Stat. (Math.) 409, Biol. 210.
528. (Biol. 528) STATISTICAL ECOLOGY SPECTRUM (3) Overview of research and instruction of particular interest to quantitative ecology faculty in the Ecology program. Prerequisite: Stat. (Biol.) 527.
534. (M.E.R. 534) DYNAMIC PROGRAMMING (3) The study of the concepts underlying model-building and optimization of dynamic systems; applications to engineering, economic, and environmental systems. Prerequisites: Stat. (Math.) 414; I.E. 405 or Q.B.A. 451.
540. STATISTICAL COMPUTING (3) Computational foundations of statistics; algorithms for linear and nonlinear models, discrete algorithms in statistics, graphics, missing data, Monte Carlo techniques. Prerequisites: Stat. (Math.) 415; Stat. 501 or 511; matrix algebra.
544. THEORY OF CONTINGENCY TABLES (3) Theory of multidimensional contingency tables; maximum likelihood estimation, sufficiency, testing, asymptotics, complete and incomplete factorial tables, quantal response models. Prerequisites: Stat. (Math.) 410 or 415; Stat. 502 or Stat. 512.
548. STATISTICAL DISTRIBUTION THEORY (3) Analytical study of nonnormal models and methods in reliability theory, survival analysis, records evaluation, scale/scale-free analysis, directional statistics. Prerequisites: Stat. (Math.) 410 or 414 or 416.
551. LINEAR MODELS I (3) A coordinate-free treatment of the theory of univariate linear models, including multiple regression and analysis of variance models. Prerequisites: Stat. (Math.) 415, Stat. 512; Math. 436 or 441.
552. LINEAR MODELS II (3) Treatment of other normal models, including generalized linear, repeated measures, random effects, mixed, correlation, and some multivariate models. Prerequisite: Stat. 551.
561. STATISTICAL INFERENCE I (3) Multiparameter estimation; linear estimation; maximum likelihood estimation; Bayesian estimation; large sample properties and procedures. Prerequisite: Stat. (Math.) 415.
562. STATISTICAL INFERENCE II (3) Testing statistical composite hypotheses; invariance principles; Bayesian statistics; large sample properties and procedures. Prerequisite: Stat. 561.
564. THEORY OF NONPARAMETRIC STATISTICS (3) Estimation and testing based on nonparametric procedures for location and regression models. Distribution theory and asymptotic efficiency. Prerequisite: Stat. (Math.) 415.
565. MULTIVARIATE ANALYSIS (3) Theoretical treatment of methods for analyzing multivariate data, including Hotelling's  $T^2$ , MANOVA, discrimination, principal components, and canonical analysis. Prerequisites: Stat. 505, 551.

## TEACHING AND CURRICULUM

572. **STATISTICAL DECISION THEORY I (3)** Structure of statistical games, optimal strategies, fixed sample-size games. Prerequisite: Stat. (Math.) 415.
580. **STATISTICAL CONSULTING PRACTICUM (2 per semester, maximum of 10)** General principles of statistical consulting and statistical consulting experience. Preparation of reports and other aspects of consulting. Prerequisites: Stat. 502; Stat. 503 or 504 or 505.
590. **COLLOQUIUM (1-3)**
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**

## TEACHING AND CURRICULUM (T & C)

ROBERT LESNIAK, *In Charge of the Graduate Program in Teaching and Curriculum*  
The Capitol Campus  
Middletown, PA 17057  
717-948-6213

**Degree Conferred:** M.Ed.

### Senior Members of the Graduate Faculty

Roy W. Allison, D.Ed. (Penn State) *Associate Professor of Education*  
Frank J. Swetz, Ed.D. (Columbia) *Professor of Mathematics and Education*  
Kathryn Towns, Ph.D. (Penn State) *Associate Professor of Educational Psychology*

### Associate Members of the Graduate Faculty

Donald K. Alexander, Ph.D. (Indiana State) *Associate Professor of Education*  
Richard I. Ammon, D.Ed. (Penn State) *Assistant Professor of Education*  
Steven M. Barnes, Ph.D. (Michigan State) *Assistant Professor of Education*  
Sally A. Chant, Ph.D. (Michigan State) *Assistant Professor of Education*  
Herbert S. Eisenstein, Ed.D. (S.U.N.Y., Buffalo) *Associate Professor of Education*  
Betty C. Holmes, Ph.D. (Texas) *Assistant Professor of Education and Reading*  
John H. Joseph, Ph.D. (Penn State) *Affiliate Assistant Professor of Education*  
Robert J. Lesniak, Ph.D. (Syracuse) *Associate Professor of Education*  
Stanley M. Miller, Ed.D. (George Peabody) *Professor of Social Sciences and Education*  
Duane R. Smith, D.Ed. (Pittsburgh) *Associate Professor of Education*  
Jacob L. Susskind, Ph.D. (George Peabody) *Assistant Professor of Social Sciences and Education*

The Master of Education in Teaching and Curriculum at Capitol Campus provides to full-time and part-time students a curriculum designed to develop master teachers for public and private school instruction and to develop education specialists (teaching certification not required) for the areas of business, industry, government, medicine, and other social services. In addition, specialties are available in particular areas, such as reading, urban education curriculum, early childhood education, elementary education, and secondary English, social studies, and mathematics education.

Specifically, the goals of the program are to develop in students (1) the ability to communicate effectively either with school-aged students and their parents or with coworkers and/or clients; (2) the ability to conduct an instructional program which provides a sound intellectual and emotional climate for learning; (3) competence in a variety of teaching methods and in the utilization of materials and content appropriate for an effective instructional program; (4) the ability to interpret and to evaluate educational literature and research; and (5) the ability to describe and to evaluate major issues and current trends in instructional curriculum practice and development.

Certification programs are also available in the areas of reading specialist (K-12) and private nursery school teachers.

### Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.



An applicant must present a baccalaureate degree from an accredited institution with a junior-senior grade-point average of 2.50. Exceptions may be made for students with special background, abilities, and interests.

Applicants are required to take the Graduate Record Examination test (GRE), which is administered by the Educational Testing Service. For dates, locations, and other information about the test, call the Counseling Center at Capitol Campus, telephone 717-948-6025, or write to the Educational Testing Service, Graduate Record Examination, Princeton, NJ 08540.

An applicant whose original language is not English is required to submit acceptable scores on the Test of English as a Foreign Language (TOEFL). The scores must be submitted before the application will be considered.

### **Degree Requirements**

Courses appropriate for a desired objective will be selected by the student and his or her adviser. After acceptance to the Graduate School, the student, with the adviser, will prepare a proposed list of requirements for the completion of the degree. This list, upon approval of the division head or a designated representative, will constitute the student's degree program, subject to annual review or review at the request of the student, the adviser, the program coordinator, or the division head.

For graduates of education and undergraduate programs, a total of 36 credits of work normally will be required. Graduates of other undergraduate programs usually complete substantially more work to satisfy the requirements for this degree. Some of this additional work may include undergraduate courses. Program requirements include 3 credits in foundations of education. Each student will be expected to complete from one-third to two-thirds of the work in courses other than Education courses. A minimum of 12 credits in 500-level courses must be completed. The last 12 credits in a student's program must be earned at Capitol Campus.

A maximum of 10 credits may be transferred into this program. However, students who transfer from the University Park Campus will have their credits evaluated on an individual basis. All transfer credits must be approved in writing by the student's adviser.

Each individual completing the Master of Education degree will be required to write a master's paper or complete a master's production or practicum. The proposal for this project must be presented to the professor selected to supervise the work and must be approved at least one full semester before the semester in which the student completes the requirements for the degree. The master's project must be written under the guidance and direction of the student's committee. Papers written as course requirements will not be acceptable as master's papers. The committee must approve the final draft of the master's project by the first day of classes of the semester in which the student expects to graduate.

A minimum grade-point average of 3.00 for work done at the University is required for graduation.

### **Student Aids**

Graduate assistantships available through this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

### **EDUCATION (EDUC)**

505. CURRICULUM FOUNDATIONS (3) Study of the philosophical, cultural, social, and human development sources and implications of the school curriculum.

506. CURRICULUM DEVELOPMENT (3) Examination of theory, issues, organization, and local school problems of curriculum development.

507. EDUCATIONAL PROGRAM EVALUATION (3) Approaches to evaluating educational programs; measurement techniques, evaluation of needs, processes, and outcomes; application of findings.

520. SEMINAR IN JUNIOR COLLEGE TEACHING (3) The history of the two-year college, responsibilities of the teacher in the college organization, and methods of teaching.

531. TECHNOLOGY IN EDUCATION (3) Theory and assessment of various communications media useful for classroom instruction, computer-assisted instruction, and programmed learning devices. Prerequisite: Educ. 461.

541. THE ROLE OF THE COOPERATING TEACHER (3) A study of the responsibilities of classroom teachers who cooperate with teacher-preparation institutions. Prerequisite: teaching experience.

550. INTERNSHIP IN JUNIOR COLLEGE (3) Teaching humanities courses in a two-year college under a master teacher, who will direct, criticize, and evaluate the intern.

## THEATRE ARTS

551. **PROBLEMS IN TEACHING READING (3)** A research-centered course in teaching reading. Prerequisite: Educ. 322, 451, 471, or 472.
560. **CLASSROOM MANAGEMENT (3)** Analysis of teaching styles, classroom behavior and interaction, organization and correlation of classroom activities and subject areas. (Requires practical application in an actual teaching situation.)
561. **PSYCHOLOGY OF READING (3)** Examination of the theoretical bases for reading which have direct practical implication for teaching reading. Prerequisites: Educ. 314, 321.
562. **DIAGNOSTIC EVALUATION OF READING PROBLEMS (3)** Utilization of formal and informal instruments and techniques appropriate in analyzing reading disabilities, grades K-12; includes practicum. Prerequisite: Educ. 321.
563. **ADVANCED METHODS IN TEACHING READING (3)** Advanced development of diagnostic and instructional techniques for teaching reading, with emphasis on individual and small group instruction. Prerequisite: Educ. 321.
564. **READING CLINIC (3-6)** A practicum course in which students display their competencies in working with children possessing reading problems. Prerequisites: Educ. 421, 422, 423, 561, 562, 563, Be.Sc. 405, 406.
571. **GREAT TEACHERS (3)** Study of one or more great teachers, e.g., Socrates, Comenius, Locke, Rousseau, Pestalozzi, Herbart, Froebel, Dewey, Kilpatrick.
572. **COMPARATIVE EDUCATION: WORLD PERSPECTIVES (3)** An evaluative comparison of American education with Western and non-Western educational systems.
583. **PROBLEMS IN TEACHING: SELECTED SUBJECT AREAS (3)** An analysis of a teaching problem with review of research literature to seek solutions to that problem. Prerequisite: consent of adviser.
584. **ANALYSIS OF RESEARCH: SELECTED TOPICS (3)** A review and analysis of research in a specified area. Prerequisite: Educ. 586 or consent of adviser.
586. **EDUCATIONAL RESEARCH DESIGNS (3)** Identification of research designs appropriate to educational field and laboratory investigations and the development of a master's project proposal. Prerequisites: 15 credits of graduate study.
587. **MASTER'S PROJECT (3)** The development of an original master's project (paper, essay, production, practicum) supervised and judged by an appropriate faculty committee. Prerequisite: consent of adviser.
589. **PROBLEMS IN URBAN EDUCATION (3)** Independent study of selected topics related to urban education.
590. **COLLOQUIUM (1-3)**
591. **EDUCATION SEMINAR (1-6)** Seminars in important, and often controversial, topics in education.
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**

## THEATRE ARTS (THEA)

ROGER N. CORNISH, *In Charge of Graduate Programs in Theatre Arts*  
103 Arts Building  
814-865-7586

**Degrees Conferred:** M.A., M.F.A.

### **Senior Members of the Graduate Faculty**

William H. Allison, M.F.A. (Yale) *Professor of Theatre Arts*  
Lowell L. Manfull, Ph.D. (Minnesota) *Professor of Theatre Arts*

### **Associate Members of the Graduate Faculty**

Douglas N. Cook, M.A. (Stanford) *Professor of Theatre Arts*  
Roger N. Cornish, Ph.D. (Minnesota) *Associate Professor of Theatre Arts*



William E. Crocken, *Associate Professor of Theatre Arts*  
 Charles H. Firmin, M.F.A. (Penn State) *Assistant Professor of Theatre Arts*  
 Anne A. Gibson, M.F.A. (Carnegie-Mellon) *Professor of Theatre Arts*  
 William J. Kelly, M.F.A. (Penn State) *Assistant Professor of Theatre Arts*  
 Douglas R. Maddox, M.F.A. (Carnegie Tech.) *Associate Professor of Theatre Arts*  
 Helen A. Manfull, Ph.D. (Minnesota) *Associate Professor of Theatre Arts*  
 Archie L. Smith, *Associate Professor of Theatre Arts*

This program pursues the following major objectives: (1) to help each student attain skills and proficiencies in theatre arts; (2) to provide the training, discipline, and opportunities essential to the development of a professional ability in at least one area of theatre arts; (3) to prepare students for active careers in academic, professional, and/or community theatre in a competitive job market; and (4) to assist students to acquire discriminating taste and critical judgment in theatre and film.

Department facilities include the Playhouse, a proscenium-thrust theatre; the Pavilion, an arena or three-quarter theatre; theatre production studios for scenic, property, and costume preparation; rehearsal and dance studios; a feature and documentary film collection; and a film laboratory with production, editing, and screening facilities.

### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by the program and authorized by the dean of the Graduate School, are required for admission. At the discretion of the program, a student may be admitted provisionally for graduate study without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Requirements for admission to the M.A. program are (1) a broad undergraduate preparation in theatre, including 3 credits each in acting, directing, stagecraft, and theatre history; and 6 credits of dramatic literature; (2) 12 credits in related subject areas such as film, oral interpretation, art, and music; (3) submission of a vita and at least three letters of recommendation.

Requirements for admission to the M.F.A. program are (1) 24 credits in theatre arts, including one course each in acting, directing, and theatre crafts; (2) submission of evidence of ability in the proposed area of specialization — auditions, prompt books, portfolios, manuscripts, and other appropriate presentations are to be submitted to the various study programs by arrangement with the department; (3) submission of a vita and at least three letters of recommendation; (4) personal interview to be arranged by the student.

Note: With few exceptions, admission to the M.F.A. specialization in directing is open only to students who are already in residence in another graduate category and are thus able to present as auditions fully mounted directing projects prepared in the facilities of the program.

### **Master of Arts Degree Requirements**

The program is designed to prepare the candidate for (1) professional employment as a theatre arts teacher on the secondary or junior college level; (2) critical study and research in preparation for the pursuit of a related doctorate or professional degree; and (3) related professional work in industry, business, or the arts. Two areas of study are required: general theatre (history, theory, criticism, dramatic literature, and research) and practical theatre (acting, directing, design, and technical theatre). A limited number of students pursuing the M.A. in Theatre Arts may concentrate in film.

A minimum of 36 credits must be earned in the program. If a student elects to write a thesis, 6 of those credits will be earned as part of the thesis process. A student electing not to do a thesis will submit for program approval two master's papers that testify to the student's research and writing ability. A master's paper should be equivalent in scope to a graduate seminar research project and must be in style and analytic quality comparable to a thesis.

### **Master of Fine Arts Degree Requirements**

The program entails specialization in one of the following areas: acting, directing; management; production (scene design, costuming, lighting, or technical direction); or playwriting.

In addition to completing required courses (see the MASTER'S DEGREES section of the Graduate Bulletin), each student must complete a final project in the area of specialization. The completion of that project is signified by committee approval of a monograph, a major report on the project's development. With the exception of management students, whose residency may be completed in four semesters, the M.F.A. program generally requires six semesters in residence.

## THEATRE ARTS

### Other Relevant Information

Students who prove deficient in required undergraduate courses may be required to take additional course work in the areas of deficiency without degree credit.

All graduate majors are required to participate in University Theatre productions in positions of responsibility.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

### FILM (FILM)

- 400. ADVANCED FILM PROJECTS (1-6)
- 436. DIRECTING FOR FILM AND TELEVISION (3)
- 446. ADVANCED SCREENWRITING (3-6)
- 472. ADVANCED FILM PRODUCTION I (3)
- 473. ADVANCED FILM PRODUCTION II (3)
- 481. AMERICAN FILM (3)
- 482. FOREIGN FILM (3)
- 483. (C.Lit. 483) FILM AND LITERATURE (3)
- 484. DOCUMENTARY IN FILM AND TELEVISION (3)
- 485. ADVANCED FILM THEORY AND CRITICISM (3)
- 489. ADVANCED FILM PRODUCTION PRACTICUM (1-12)
- 494. RESEARCH TOPICS (1-3, maximum of 12)
- 495. INTERNSHIP AND FIELD PRACTICUM (1-12)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
- 499. FOREIGN STUDIES — FILM (1-6)

### THEATRE ARTS (THEA)

- 400. ADVANCED THEATRE PROJECTS (1-6)
- 401. THEATRE HISTORY I: ANCIENT TO 1700 (3)
- 402. THEATRE HISTORY II: FROM 1700 TO PRESENT (3)
- 405. THEATRE HISTORY: AMERICAN THEATRE (3)
- 409. FUNDAMENTALS OF CREATIVE PERFORMANCE FOR CLASSROOM TEACHERS (3)
- 420. ACTING VI (3)
- 421. ACTING VII (3)
- 422. ADVANCED VOICE AND SPEECH I (2)
- 423. ADVANCED VOICE AND SPEECH II (2)
- 424. ADVANCED MOVEMENT AND DANCE FOR THE ACTOR I (2)
- 425. ADVANCED MOVEMENT AND DANCE FOR THE ACTOR II (2)
- 426. CHILDREN'S THEATRE (3)
- 427. THEATRE MAKEUP (2)
- 428. CREATIVE DRAMA AND PERFORMANCE IN CHILDREN'S THEATRE (3)
- 429. THEATRE PERFORMANCE PRACTICUM (1-3 per semester)
- 430. ACTING PROFESSIONALLY (2)
- 434. DIRECTING (3)
- 435. REHEARSAL METHODS FOR THE DIRECTOR (3)
- 436. PROJECTS IN DIRECTING (1)
- 440. PRINCIPLES OF PLAYWRITING (3)
- 445. ADVANCED PLAYWRITING (3-6)
- 450. SCENIC DESIGN II (3 per semester, maximum of 6)
- 453. ADVANCED SCENE PAINTING (1-2 per semester, maximum of 6)
- 457. SCENE DESIGN FOR PRODUCTION (1 per semester, maximum of 6)
- 460. COSTUME DESIGN II (3)
- 461. COSTUME CONSTRUCTION II (3)
- 466. COSTUME CONSTRUCTION FOR PRODUCTION (1 per semester, maximum of 6)
- 467. COSTUME DESIGN FOR PRODUCTION (1 per semester, maximum of 6)
- 470. LIGHTING DESIGN II (3)
- 477. LIGHTING DESIGN FOR PRODUCTION (1 per semester, maximum of 6)



480. TECHNICAL PRODUCTION II (3)
481. STAGE AND PRODUCTION MANAGEMENT (3)
485. SOUND FOR THEATRE PRODUCTION (3)
487. TECHNICAL PROJECTS FOR PRODUCTION (1 per semester, maximum of 6)
489. THEATRE PRODUCTION PRACTICUM (1-6 per semester, maximum of 12)
495. INTERNSHIP PRACTICUM (1-6 per semester, maximum of 12)
496. INDEPENDENT STUDIES (1-18)
497. SPECIAL TOPICS (1-9)
500. THEATRE RESEARCH: SOURCES AND PROCEDURE (3) Source materials and techniques as applied to theatre research; the form and content of theses and monographs.
503. THEATRE CRITICISM AND THEORY (3) Graduate seminar in examination and application of major dramatic and critical theories from Aristotle to present. Prerequisite: Thea. 500.
504. ACTING AND DIRECTING THEORY (3) The actor and director as related to the cultural environment from the Greek theatre through the post-Stanislawskian theorists. Prerequisite: Thea. 500.
505. THEATRE HISTORY (3) Specific aspects of theatre from ancient times to the present.
520. GRADUATE ACTING I (4) Synthesis of performance technique, including voice, movement, and acting; exercises, monologues, and scene study; principal focus on realism.
521. GRADUATE ACTING II (4) A continuation of Thea. 520. Prerequisite: Thea. 520.
522. GRADUATE ACTING III (3) Advanced exercises, monologue, and scene study. Principal focus on nonrealistic material. Prerequisite: Thea. 521.
523. GRADUATE ACTING IV (3) A continuation of Thea. 522. Prerequisite: Thea. 522.
530. DIRECTING SEMINAR (2) Problems of directing: casting, stage forms, styles, and directing techniques. Prerequisite: Thea. 435.
531. DIRECTING SEMINAR (1) Special problems in directing for the M.F.A. directing student. Prerequisite: admission to the M.F.A. directing program.
533. PROJECTS IN DIRECTING (1-2) Approved directing projects for the M.F.A. directing student. Prerequisites: Thea. 435; admission to the M.F.A. directing program.
540. PLAYWRITING (3-6) Focus on problems in writing the full-length script through seminar, play reading, and individual session.
543. PROJECTS IN PLAYWRITING (1-9) Preparation of the script for revision during and following production of the student's original play. Prerequisite: production approval.
550. SCENIC DESIGN III (3 per semester, maximum of 9) Advanced design; concentration on conceptualization, visual communication skills, portfolio production. Prerequisites: Thea. 450; portfolio review.
551. SCENIC DESIGN IV (1 per semester, maximum of 6) Advanced projects in scenic design. Prerequisite: Thea. 550 or portfolio review.
557. SCENIC DESIGN FOR PRODUCTION (1 per semester, maximum of 6) Design and execution of production design projects. Prerequisite: approval of proposed project by instructor prior to registration.
560. COSTUME DESIGN III (3 per semester, maximum of 9) Advanced costume design with emphasis on total production concept. Prerequisite: Thea. 460 or portfolio review.
561. COSTUME DESIGN AND CONSTRUCTION (1-6) Advanced special projects for the graduate designer and costumer. Prerequisites: Thea. 461 or 560; approval of proposed project by instructor prior to registration.
564. HISTORY OF COSTUME (3) Exploration of dress from Egyptian to modern. Prerequisite: permission of instructor prior to registration.
566. COSTUME CONSTRUCTION FOR PRODUCTION (1 per semester, maximum of 6) Execution of production in construction and shop management. Prerequisite: approval of proposed project by instructor prior to registration.

## URBAN AND REGIONAL PLANNING

567. **COSTUME DESIGN FOR PRODUCTION** (1 per semester, maximum of 6) Design and execution of production design projects. Prerequisite: approval of proposed project by instructor prior to registration.
570. **STAGE LIGHTING DESIGN III** (3) Advanced techniques in the art of theatrical lighting design. Prerequisite: Thea. 470.
577. **LIGHTING DESIGN FOR PRODUCTION** (1 per semester, maximum of 6) Design and execution of production design projects. Prerequisite: approval of proposed project by instructor prior to registration.
580. **TECHNICAL PRODUCTION III** (3) Design consultation and specification of equipment, systems, and movable structures for new theatres; structures and projection devices for production. Prerequisite: Thea. 480.
581. **THEATRE ADMINISTRATION I** (3) Organizational structure and personnel; contracts; unions; budget preparation and control; administrative styles in theatre, opera, and dance. Prerequisite: Thea. 481.
582. **THEATRE ADMINISTRATION II** (3) Fund raising; promotion; audience development; audience survey technique; program development and strategies. Prerequisite: Thea. 581.
583. **PROJECTS IN THEATRE ADMINISTRATION, MANAGEMENT, AND OPERATIONS** (1-6)
584. **PERFORMING ARTS FACILITY MANAGEMENT** (3) Management practices in theatres, auditoriums, and arts complexes; environmental systems; acoustical considerations; programming and community relations. Prerequisite: Thea. 481.
585. **THEATRE PLANNING** (3) Processes and problems in planning and designing theatres: performance, audience, and technical requirements.
587. **TECHNICAL PROJECTS FOR PRODUCTION** (1 per semester, maximum of 6) Execution of assigned technical projects for theatre production. Prerequisite: approval of proposed project by instructor prior to registration.
590. **COLLOQUIUM** (1-3)
591. **SPECIAL PROBLEMS IN FILM AND TV** (1-3 per semester)
595. **INTERNSHIP** (1-3) Professional field experience in theatre performance, production, and management assignments. Prerequisite: approval in internship by instructor prior to registration.
596. **INDIVIDUAL STUDIES** (1-6)
597. **SPECIAL TOPICS** (1-6)
602. **SUPERVISED EXPERIENCE IN COLLEGE TEACHING** (1-3 per semester, maximum of 6)

## URBAN AND REGIONAL PLANNING (UR PL)

IRVING HAND, *Program Chairman*  
The Capitol Campus  
Middletown, PA 17057  
717-948-6173

**Degree Conferred:** M.R.P.

### Senior Members of the Graduate Faculty

Francis Ferguson, Ph.D. (Columbia) *Professor of Environmental Design*  
Irving Hand, M.C.P. (M.I.T.) *Associate Professor of State and Regional Planning*  
Robert E. McDermott, Ph.D. (Duke) *Professor of Environmental and Health Systems*

### Associate Members of the Graduate Faculty

E. Drannon Buskirk, Jr., Ph.D. (Michigan) *Assistant Professor of Urban and Regional Planning*  
Robert A. Simko, Ph.D. (Indiana) *Associate Professor of Social Science and Geography*

The objective of this interdisciplinary program is to train professional planners who will be aware of the needs of citizens so that they can develop programs for sound social, political, economic, and cultural advancement through the enlightened management of all resources. This degree program has



been authorized to be offered at The Capitol Campus. In addition, The Capitol Campus has been authorized to offer this program at the King of Prussia Graduate Center.

The program is officially recognized by the American Planning Association.

### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

For admission, a student should have had at least one course each in economics, graphics, and statistics. Students may be admitted with limited deficiencies but are required to remove the deficiencies early in the program without graduate degree credit. Applicants should submit scores on the Graduate Record Examination with their application. Students with a 2.50 junior-senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces available. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

### **Degree Requirements**

To earn the master's degree in Regional Planning, a student must complete 45 credits, 24 of which must be at the 500 or 600 level. The courses include 21 credits of required core courses; 6 or 9 credits from a master's project or thesis; 15 or 18 credits of elective courses to allow students to pursue their career needs and interests in areas such as planning administration, natural resources, physical planning, and computer graphics.

The master's project option is available, permitting a master's paper with an applied research emphasis focusing on selected case study materials and application.

### **Other Relevant Information**

An adviser is assigned to the student upon admission to the program. The advising relationship is expected to involve a regular schedule each semester, one which the student and faculty member are encouraged to develop. In addition, an adviser will be assigned, as appropriate, with respect to the master's project or thesis.

### **Student Aids**

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## **REGIONAL PLANNING (UR PL)**

400. PRINCIPLES OF REGIONAL PLANNING (3-6)

410. PLANNING PROGRAMS (3)

440. PROBLEMS IN COMMUNITY AND REGIONAL PLANNING (1-9)

500. (P.Adm. 503) RESEARCH METHODS (1-3) Examination of research methodologies relevant to administration, planning, and public policy. Prerequisite: 3 credits in statistics.

501. APPLIED METHODOLOGIES IN REGIONAL PLANNING (3) Selected methodologies used in planning, including demographic projections, simulations, network analyses, threshold analyses, allocation and location models.

502. REGIONAL SYSTEMS ANALYSIS (3) Developmental planning, its characteristics and consideration in a cross-cultural context, including study of selected approaches and analysis critiques.

510. PLANNING TECHNIQUES AND ANALYSIS: SOCIO-ECONOMIC (3) Socio-economic considerations in planning, including data collection and analysis for planning purposes.

520. PLANNING TECHNIQUES AND ANALYSIS: ENVIRONMENTAL (3) Application of selected concepts and methodologies in environmental planning.

530. PLANNING TECHNIQUES AND ANALYSIS: PHYSICAL (3) The physical city and its shaping by political, economic, social, and cultural conditions.

## VETERINARY SCIENCE

- 540. PROBLEMS IN REGIONAL PLANNING (3) Planning problems in selected subject areas.
- 542. HOUSING FOR URBAN PLANNERS (3) An introduction to housing and housing issues in an urban environment.
- 543. COMMUNITY ENERGY PLANNING (3) Appraisal methods for community planning, development, and management, consistent with dramatically rising energy costs.
- 544. RURAL DEVELOPMENT PLANNING (3) Planning and implementing practical approaches to rural development.
- 545. PLANNING IN DEVELOPING COUNTRIES (3) Approaches to planning and implementing urban and regional development in lesser developed countries.
- 546. LAND USE PLANNING AND MANAGEMENT (3) Land use planning and management: theory and practice.
- 547. ENVIRONMENTAL PLANNING (3) Analytical skills in environmental planning.
- 587. MASTER'S PROJECT (1-6) An original scholarly master's project initiated by the student, supervised by an appropriate professor, and judged by a committee.
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)

## VETERINARY SCIENCE (V SC)

C. S. CARD, *Head of the Department*  
115 Animal Industries Building  
814-865-7696

**Degrees Conferred:** Ph.D., M.S.

### Senior Members of the Graduate Faculty

Clyde S. Card, D.V.M., Ph.D. (Colorado State) *Professor of Veterinary Science*  
Robert J. Eberhart, D.V.M., Ph.D. (Penn State) *Professor of Veterinary Science*  
Frederick G. Ferguson, D.V.M., Ph.D. (Pennsylvania) *Professor of Veterinary Science*  
Edward J. Massaro, Ph.D. (Texas) *Professor of Veterinary Science*  
Hansjakob Rothenbacher, D.V.M., Ph.D. (Michigan State) *Professor of Veterinary Science*  
Richard W. Scholz, Ph.D. (Purdue) *Professor of Veterinary Science*  
Arian Zarkower, D.V.M., Ph.D. (Cornell) *Professor of Veterinary Science*

### Associate Members of the Graduate Faculty

Maximillian O. Braune, Ph.D. (Penn State) *Associate Professor of Veterinary Science*  
Barrett S. Cowen, Ph.D. (Cornell) *Associate Professor of Veterinary Science*  
Lester C. Griel, M.S., D.V.M. (Pennsylvania) *Associate Professor of Veterinary Science*  
John E. Harkness, M.S., D.V.M. (Michigan State) *Associate Professor of Veterinary Science*  
J. F. Kavanaugh, D.V.M. (Cornell) *Professor of Veterinary Science*  
William H. Patton, D.V.M., Ph.D. (Wisconsin) *Assistant Professor of Veterinary Science*  
C. Channa Reddy, Ph.D. (Indian Inst. of Sci.) *Assistant Professor of Veterinary Science*  
Richard A. Wilson, Ph.D. (Montana State) *Associate Professor of Veterinary Science*  
Terrance M. Wilson, D.V.M., Ph.D. (Ontario) *Associate Professor of Veterinary Science*

The graduate program in Veterinary Science is designed to provide flexibility in graduate work while providing opportunities to study immunology, microbiology, animal nutrition, veterinary pathology, physiology, or toxicology, usually as related to problems seen in domestic animals.

Graduate instruction is directed by graduate faculty members from the Department of Veterinary Science and related units including dairy and animal science, biochemistry, biology, biophysics, immunology, animal nutrition, physiology, zoology, and others. The Ph.D. program is designed for completion in three to four academic years. Doctoral candidates usually complete certain required courses and obtain laboratory experience before selecting an area of specialization and completing an original research problem, including the defense of the Ph.D. dissertation.

Facilities for departmental research include laboratories in Animal Industries Building, Poultry Disease Laboratory, Animal Disease Laboratory, Centralized Biological Laboratory, and Center for



Air Environment Studies. Opportunities to utilize specialized research equipment exist in other related facilities. The University has an extensive, modern library. A large University Computer Center and consultation service are available.

### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Applicants with a 3.00 or better grade-point average and appropriate course backgrounds will be considered for admission. Applicants should have a baccalaureate degree in biological science or a degree as a graduate veterinarian or equivalent. Undergraduate preparation should include biology, chemistry, physics, mathematics through calculus, and preferably biostatistics and biochemistry.

Students generally progress from M.S. to the Ph.D. program; however, in special cases well-qualified students may be admitted directly into the Ph.D. program.

### **Master's Degree Requirements**

A minimum of 30 graduate credits is required for the M.S. degree. Satisfactory completion of the following three courses or their equivalent is required of all degree candidates: Ag. 400, Biometry, 3 credits; Bioch. 401, General Biochemistry, 3 credits; Bioch. 402, General Biochemistry, 3 credits.

All graduate students are required to complete one semester of V.Sc. 590 (Colloquium) each year as well as 8 credits from a list of courses. At least 18 credits must be taken in 500- and 600-level courses.

Veterinary Science requires no program-specific qualifying examinations, and there is no communication/language requirement for the M.S.

A thesis is required of all candidates for the M.S. degree.

### **Doctoral Degree Requirements**

The communication requirement for the Ph.D. may be satisfied by completion of one of three options: (1) demonstrating in a foreign language, competence equivalent to a level normally attained by obtaining a grade of B or better in at least two undergraduate courses in a foreign language approved by the student's committee, or by passing a reading proficiency examination given by a foreign language department; (2) demonstrating competence in scientific writing by obtaining a grade of B or better in two technical writing courses, Engl. 218 (Technical Writing) and Engl. 418 (Advanced Technical Writing and Editing); (3) demonstrating a working knowledge of computer science as applied to biologic systems by obtaining a grade of B or better in at least two 400- or 500-level courses in computer science. The communication requirement must be completed before the comprehensive examination is taken.

Satisfactory completion of the following three courses or their equivalent is required of all degree candidates: Ag. 400, Biometry, 3 credits; Bioch. 401, General Biochemistry, 3 credits; Bioch. 402, General Biochemistry, 3 credits. All Ph.D. candidates are required to complete one semester of V.Sc. 590 (Colloquium) each year, at least two 400- or 500-level courses in statistics, and 8 credits from a list of courses. Certain rules regarding course level and type (course work and research) apply.

A candidacy examination is given to students entering the Ph.D. program and after completing at least twelve hours of postbaccalaureate course work.

### **Other Relevant Information**

After a student has been admitted to graduate study in the department, an adviser will be appointed by the department head. This person may be a member of the eventual M.S. committee or someone else assigned the responsibility for directing the student's scheduling of course work. In the case of a doctoral candidate, the person may be a member of the eventual doctoral committee or someone else designated the responsibility for directing the student's scheduling of course work. The adviser is also responsible for initiating the scheduling of the candidacy examination.

### **Student Aids**

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## VOCATIONAL EDUCATION

### VETERINARY SCIENCE (V SC)

405. LABORATORY ANIMAL SCIENCE (3) *Harkness*  
407. DAIRY HERD HEALTH PROGRAMS (2)  
418. METHODS OF ANIMAL CELL CULTURE (3) *Patton*  
420. GENERAL ANIMAL PATHOLOGY (3) *Rothenbacher*  
496. INDEPENDENT STUDIES (1-18)
525. MECHANISMS OF HYPERSENSITIVITY AND IMMUNOPATHOLOGY (3) Concepts of hypersensitivity and special consideration of immunopathological conditions. Prerequisites: Biol. 437, Micrb. 410, and 3 credits of pathology. *Zarkower and Ferguson*
528. DIAGNOSTIC PATHOLOGY (3-9) Gross examination of animals and birds, their tissues and body fluids for pathologic changes. Prerequisites: 6 credits in pathology, microbiology, or infectious diseases. *Card*
535. ACQUIRED AND CONGENITAL DISORDERS OF METABOLISM (3) Abnormalities and alterations in metabolism due to dysfunctions of animal organs. Prerequisites: 6 credits in general biochemistry and 3 credits in animal physiology. *Scholz*
550. EXPERIMENTAL ANIMAL SURGERY (3) Principles of surgical preparation of experimental animal models for biological research, including aseptic procedures, anesthesia, surgical techniques, and aftercare. Prerequisites: Biol. 42, 421; V.Sc. 405. *Kavanaugh*
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## VOCATIONAL EDUCATION (VOCED)

FREDERICK G. WELCH, *In Charge of Graduate Programs in Vocational Education*  
103 Rackley Building  
814-863-0802

**Degrees Conferred:** Ph.D., D.Ed.

### Senior Members of the Graduate Faculty

Samuel Curtis, D.Ed. (Penn State) *Professor of Agricultural Education*  
Ronald L. Koble, D.Ed. (Penn State) *Associate Professor of Education*  
Thomas E. Long, D.Ed. (Penn State) *Professor of Vocational Education and Counselor Education*  
Gene M. Love, Ph.D. (Penn State) *Professor of Agricultural Education*  
M. Eloise Murray, Ph.D. (Penn State) *Associate Professor of Home Economics Education*  
David L. Passmore, Ph.D. (Minnesota) *Associate Professor of Vocational Education*  
Elizabeth M. Ray, Ph.D. (Cornell) *Professor of Home Economics Education*  
Twyla M. Shear, Ed.D. (Michigan State) *Professor of Home Economics Education*  
John M. Shemick, Ed.D. (Illinois) *Associate Professor of Industrial Arts Education*  
Richard F. Stinson, Ph.D. (California) *Professor of Agricultural Education and Horticulture*  
Susan Weis, Ph.D. (Penn State) *Associate Professor of Home Economics Education*  
Frederick G. Welch, D.Ed. (Penn State) *Associate Professor of Vocational Education*  
Jerry L. Wircenski, Ph.D. (Ohio State) *Associate Professor of Vocational Education*

### Associate Members of the Graduate Faculty

William I. Lindley, Ph.D. (Cornell) *Assistant Professor of Agriculture Extension Education*  
James H. Mortenson, Ph.D. (Penn State) *Assistant Professor of Agricultural Education*  
Raymond H. Morton, Ph.D. (Ohio State) *Assistant Professor of Agricultural Education*  
William Williams, D.Ed. (Penn State) *Associate Professor of Agricultural and Extension Education*  
Edgar P. Yoder, Ph.D. (Ohio State) *Assistant Professor of Agricultural Education*

This intercollege program crossing fields within vocational education prepares graduates for positions in local school districts, vocational technical schools, community colleges, four-year colleges and universities, and state departments of education, with emphasis in administration and supervision, research, teacher education, curriculum development and design, cooperative education, corrections education, and industrial training.



A minimum of 45 credits is required in the major, to be divided among vocational education, general professional education, and social and behavioral science courses. A minor program of study is required for the D.Ed. degree and is optional for the Ph.D. degree, and may be developed within one of five social and behavioral science options, in general studies, or in other areas approved by the candidate's committee.

The communication and foreign language requirement for the Ph.D. degree may be satisfied from nine options, which include foreign languages, computer science, statistics, technical writing, and philosophic thought.

#### **Admission Requirements**

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

For admission, students must have a master's degree. Either the master's degree or the bachelor's degree must be in a vocational education specialization, or the applicant must have professional experience in vocational education.

#### **Other Relevant Information**

Courses appropriate to these degrees taught in the three participating departments are Ag.Ed. 418v, 420v, 424v, 426v, 434v, 501v, 502v, 508v, 509v, 520v, 521v, 524v, 530v, 590v, 596v; I.Ed. 402, 408, 409, 415, 427, 446, 450, 501, 506, 510, 550, 556, 557, 558, 559, 560; H.E.Ed. 406, 477, 478, 481, 482, 503, 504, 510, 511, 518, 521, 577.

#### **Student Aids**

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

#### **VOCATIONAL EDUCATION (VOCED)**

- 413. (Spl.Ed. 413) VOCATIONAL EDUCATION FOR SPECIAL-NEEDS LEARNERS (3)
- 417. (Cn.Ed. 417) CAREER EDUCATION: ORIGINS, THEORY, IMPLEMENTATION (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

500. PHILOSOPHY OF VOCATIONAL EDUCATION (3) Influence of legislative, economic, and social-psychological developments on the status and role of public vocational education in the United States.

508. ADMINISTRATION OF VOCATIONAL EDUCATION (3) Concepts, strategies in administration of vocational programs in comprehensive high schools, area vocational technical schools, proprietary schools, and colleges.

590. COLLOQUIUM (1-3)

595. INTERNSHIP (1-10) Internship at cooperating school, governmental agency, or research institution, under supervision of graduate faculty. Prerequisites: admission to candidacy and completion of 15 credits in residence beyond master's degree.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

## VOCATIONAL INDUSTRIAL EDUCATION (VI ED)

FREDERICK G. WELCH, *In Charge of Graduate Programs in Vocational Industrial Education*  
103 Rackley Building  
814-863-0802

**Degrees Conferred:** Ph.D., D.Ed., M.S., M.Ed.

### Senior Members of the Graduate Faculty

Ronald L. Koble, D.Ed. (Penn State) *Associate Professor of Education*  
Thomas E. Long, D.Ed. (Penn State) *Professor of Vocational Education and Counselor Education*  
David L. Passmore, Ph.D. (Minnesota) *Associate Professor of Vocational Education*  
John M. Shemick, Ed.D. (Illinois) *Associate Professor of Industrial Arts Education*  
Frederick G. Welch, D.Ed. (Penn State) *Associate Professor of Vocational Education*  
Jerry L. Wircenski, Ph.D. (Ohio State) *Associate Professor of Vocational Education*

### Associate Member of the Graduate Faculty

Wayne L. Detwiler, Sr., D.Ed. (Penn State) *Assistant Professor of Vocational Education*

Emphasis may be placed upon preparation for teaching, supervision, administration, research, teacher education, or training in industry. The primary focus of the program is preparation for entry into responsible positions within the broadly conceived field of vocational industrial education.

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Persons admitted must have successfully completed a B.S. degree with a 2.50 grade-point average in vocational industrial education or fields related to vocational, safety, or technical education, or health occupations. Two years or more of experience in vocational industrial education, industrial training, military technical training, or work experience in an occupation related to vocational industrial education, industrial training, vocational education, health occupations, safety education, or technical education are also required for admission. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

### Degree Requirements

The communication and foreign language requirement for the Ph.D. degree may be met by the successful completion of selected courses in statistics and computer programming.

### Student Aids

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AIDS section of the Graduate Bulletin.

## INDUSTRIAL EDUCATION (I ED)

- 402. SUPERVISION OF VOCATIONAL EDUCATION (3)
- 408. OCCUPATIONS (3)
- 409. TESTS AND MEASUREMENTS (3)
- 415. PROBLEMS IN COORDINATING VOCATIONAL EDUCATION (3)
- 427. ADVANCED COURSE OF STUDY BUILDING (3)
- 446. IMPROVEMENT OF INSTRUCTION IN VOCATIONAL EDUCATION (4)
- 450. SHOP LAYOUT AND MANAGEMENT (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

501. SEMINAR IN VOCATIONAL EDUCATION (6) Conferences, investigations, and discussion for advanced students and mature persons who have had experience as teachers, supervisors, or administrators.



506. ADMINISTRATION OF VOCATIONAL EDUCATION (3) The job of the local director of industrial education in organizing and developing city and other local programs of industrial education. Prerequisites: 6 credits in industrial education, valid director's certificate, or equivalent training and experience.

510. VOCATIONAL EDUCATION FOR ADMINISTRATORS (3) Designed for school administrators and supervisors who desire an understanding of practical arts and vocational education. Prerequisite: I.Ed. 1 or trade or teaching experience.

550. RESEARCH IN VOCATIONAL EDUCATION (3) Research techniques in vocational industrial education.

556. FEDERAL LEGISLATION (2-3) Recent federal legislative activities and executive orders that bear directly and indirectly upon industrial education.

557. PRESENT-DAY LOCAL, PERSONNEL, AND CURRICULUM PROBLEMS (2-3) Various plans, techniques, and practices.

558. STATE AND LOCAL SUPERVISION AND ADMINISTRATION (2-3) The more important recent problems in organization, supervision, and administration.

559. VOCATIONAL TECHNICAL EDUCATION (2-3) Problems of organization and administration of programs of technical education at the secondary and postsecondary levels. Prerequisites: 6 credits in industrial education, valid director's certificate, or equivalent training and experience.

560. PHILOSOPHY OF INDUSTRIAL EDUCATION (3) Principles and beliefs of progressive industrial education; literature for evaluating instructional practices. Prerequisites: 12 credits in industrial education or teaching experience.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

## VOCATIONAL INDUSTRIAL EDUCATION (VI ED)

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## WILDLIFE MANAGEMENT (W L M)

ROBERT S. BOND, *Director of the School of Forest Resources*  
101 Ferguson Building  
814-865-7541

**Degrees Conferred:** M.S., M.Agr.

### Senior Members of the Graduate Faculty

Dean E. Arnold, Ph.D. (Cornell) *Adjunct Assistant Professor of Aquatic Ecology*  
Robert C. Baldwin, Ph.D. (Penn State) *Assistant Professor of Wood Science and Technology*  
Paul R. Blankenhorn, Ph.D. (Penn State) *Associate Professor of Wood Technology*  
Robert S. Bond, Ph.D. (S.U.N.Y.) *Professor of Forest Resources*  
Todd W. Bowersox, Ph.D. (Penn State) *Associate Professor of Silviculture*  
David R. DeWalle, Ph.D. (Colorado) *Professor of Forest Hydrology*  
Henry D. Gerhold, Ph.D. (Yale) *Professor of Forest Genetics*  
Russell J. Hutnik, Ph.D. (Duke) *Professor of Forest Ecology*  
Peter Labosky, Ph.D. (Virginia Polytechnic) *Associate Professor of Wood Science and Technology*  
James A. Lynch, Ph.D. (Penn State) *Associate Professor of Forest Hydrology*  
Larry H. McCormick, Ph.D. (Penn State) *Assistant Professor of Forest Resources*  
Wayne L. Myers, Ph.D. (Michigan) *Associate Professor of Forest Biometrics*  
Robert D. Shipman, Ph.D. (Michigan State) *Professor of Forest Ecology*  
William E. Sopper, Ph.D. (Yale) *Professor of Forest Hydrology*  
Kim C. Steiner, Ph.D. (Michigan State) *Associate Professor of Forest Genetics*  
Gerald L. Storm, Ph.D. (Minnesota) *Adjunct Assistant Professor of Wildlife*  
Brian J. Turner, Ph.D. (Yale) *Associate Professor of Forest Management*  
Ben W. Twight, Ph.D. (Washington) *Associate Professor of Forest Resources*  
James S. Wakeley, Ph.D. (Utah) *Associate Professor of Wildlife Ecology*  
Richard H. Yahner, Ph.D. (Ohio) *Assistant Professor of Wildlife Management*

### Associate Members of the Graduate Faculty

Robert P. Brooks, Ph.D. (Massachusetts) Assistant Professor of Wildlife Technology  
Edward S. Corbett, Ph.D. (Penn State) Adjunct Assistant Professor of Forest Resources  
Howard G. Halverson, Ph.D. (Arizona) Adjunct Associate Professor of Forest Resources  
Gordon M. Heisler, Ph.D. (S.U.N.Y.) Adjunct Assistant Professor of Forest Resources  
Walter W. Johnson, Ph.D. (Oregon State) Associate Professor of Forest Resources Extension  
Paul C. Kersavage, Ph.D. (Michigan) Assistant Professor of Wood Technology  
Rex E. Melton, M.F. (Michigan) Professor of Forestry  
Bruce E. Michie, Ph.D. (Wisconsin) Assistant Professor of Forest Resources  
Terry D. Rader, Ph.D. (Cornell) Associate Professor of Forest Resources Extension  
William E. Sharpe, Ph.D. (West Virginia) Assistant Professor of Forest Resources Extension  
Charles H. Strauss, Ph.D. (Penn State) Associate Professor of Forest Economics  
Walter M. Zilkowski, Ph.D. (Massachusetts) Assistant Professor of Wildlife Science

Programs are designed to give students an understanding of the biology and management of wildlife species and their environments, and include training in wildlife ecology, nutrition, physiology, behavior, and pathology of a wildlife species or species group; study of successional stages, land use, and management of various habitats and their impact on wildlife populations; population dynamics and manipulation of animal numbers; and studies of recreational, aesthetic, and socioeconomic values of wildlife. Most programs of study are strengthened by including appropriate courses offered by related departments. A Ph.D. degree in Forest Resources allows specialization in wildlife ecology and management at the doctoral level (see Forest Resources).

### Admission Requirements

*Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. (For conditions of provisional admission, see the APPLICATION AND ADMISSION section of the Graduate Bulletin.) Requirements listed below are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.*

Application materials should be submitted before February by those who want to begin in summer or fall. For admission, an applicant should have at least a 2.75 grade-point average, a 3.00 junior-senior average, and courses that are basic to the individual's field of specialization. Ordinarily these include 12 credits in communication, 12 credits in social sciences and humanities, 12 credits in quantification including calculus and statistics, 8 credits in chemistry and /or physics, 8 credits in biological sciences, and 18 credits in forest products, forestry, wildlife, or related courses. Graduate Record Examination scores, three reference reports (forms supplied on request), and a brief statement describing the applicant's academic goals, career interests, and special qualifications are required. The best-qualified applicants will be accepted up to the number of spaces available. Exceptions to admission requirements may be made for students with special backgrounds, abilities, and interests.

### Master's Degree Requirements

M.S.: In addition to Graduate School requirements, 6 credits of statistics and 2 credits of colloquium are required. A *Research Brief* must accompany the thesis when submitted for the director's signature.

M.Agr.: Candidates will elect a minimum of 15 credits of graduate-level courses in departments such as Agricultural Education, Instructional Media, Journalism, Recreation and Parks, Speech Communication, English, and Theatre. Any deficiencies in a student's resource specialty, as judged by his or her advisory committee, must be remedied. An acceptable paper on a selected professional problem or a report on internship training worth 3 credits or more also is required.

### Other Relevant Information

Each entering student receives individual guidance from an adviser, and later from his or her committee, in designing a program of studies and research based on his or her own interests. The student is responsible for conforming to all requirements summarized in the "Graduate Studies Handbook" of the School of Forest Resources, and for completing the degree program within a reasonable time, i.e., two years for a master's degree and three years for a Ph.D.

### Student Aids

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AIDS section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:



## OTHER COURSES AND OPTIONS CARRYING GRADUATE CREDIT

**FOREST RESOURCES: JESSE ROSSITER RAPP MEMORIAL SCHOLARSHIP** — Available to graduate students in the School of Forest Resources who are not holding assistantships as graduate students. Apply to the School of Forest Resources' Scholarships, Loans, and Awards Committee.

**ROGER M. LATHAM MEMORIAL AWARD** — Awarded to outstanding graduate students specializing in wildlife management after at least one semester in residence.

### **WILDLIFE (WIDL)**

- 408. MAMMALOGY (3)
  - 435. WILDLIFE ECOSYSTEMS (3)
  - 446. WILDLIFE ECOLOGY (3)
  - 447. WILDLIFE MANAGEMENT (3)
  - 492. WILDLIFE RESEARCH TECHNIQUES (4)
  - 495. WILDLIFE INTERNSHIP (1-6)
  - 496. INDEPENDENT STUDIES (1-18)
  - 497. SPECIAL TOPICS (1-9)
546. TOPICS IN WILDLIFE POPULATION ECOLOGY (3) Topics in population ecology that have relevance to wildlife research and management. Prerequisites: Wildl. 446, 447.
547. WILDLIFE MANAGEMENT (3) Management, maintenance, and manipulation of wildlife populations and habitat. Prerequisite: Wildl. 447.
551. WILDLIFE BIOMETRICS AND POPULATION ANALYSIS (3) Application of biometrics and mathematics to concepts and problems in wildlife ecology with emphasis on population analysis. Prerequisites: 3 credits in animal ecology and 6 credits in biometrics or statistics.
555. PERSPECTIVE IN WILDLIFE ECOLOGY (3) Discussion of current topics in evolutionary, community, and behavioral ecology that are applicable to wildlife research and management.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## **OTHER COURSES AND OPTIONS CARRYING GRADUATE CREDIT**

The following courses are interdisciplinary or in fields in which graduate major work is not offered at this institution. The courses, however, carry graduate credit and, with the approval of the major department head or program chairman, may be applied toward the requirements for a degree either as elective courses or as a part of a general studies program. The usual restrictions upon the use of 400-series courses in degree programs apply to these courses.

### **ADMINISTRATION OF JUSTICE (ADM J)**

- 401. PROBATION, PAROLE, AND PARDONS (3)
- 410. CORRECTIONAL COUNSELING PROCESSES (3)
- 420. SPECIAL OFFENDER TYPES (3-6)
- 421. VIOLENT CRIME IN THE UNITED STATES (3)
- 422. VICTIMLESS CRIMES AND THE ADMINISTRATION OF JUSTICE (3)
- 430. CORRECTIONAL INSTITUTIONS AND SERVICES (3)
- 440. FUNDAMENTAL TECHNIQUES OF SCIENTIFIC CRIMINAL INVESTIGATION (3)
- 441. THE JUVENILE JUSTICE SYSTEM (3)
- 445. (Com.D. 445) CRIMINAL JUSTICE AND THE COMMUNITY (3)
- 460. HISTORY AND FUNCTION OF CRIMINAL JUSTICE COMPONENTS (3)
- 462. COMPARATIVE CRIMINAL JUSTICE SYSTEMS (3)
- 470. LAW OF CRIMES AND CORRECTIONS (3)
- 471. LEGAL RIGHTS, DUTIES, LIABILITIES OF CRIMINAL JUSTICE PERSONNEL (3)

## OTHER COURSES AND OPTIONS CARRYING GRADUATE CREDIT

- 472. CRIME AND THE AMERICAN COURT SYSTEM (3)
- 482. SEMINAR, CRIMINAL JUSTICE AGENCY ADMINISTRATION (3)
- 485. POLICING IN AMERICA (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

### **AGRICULTURE, GENERAL (AG)**

- 400. INTRODUCTORY BIOMETRY (3)

### **BEHAVIORAL SCIENCE (BEHSC)**

- 410. BIostatISTICS (2)

501. BEHAVIORAL SCIENCE (3) Integration of biopsychosocial substrates of behavior variability in behavior, growth, and development; and behavioral correlates of disease and health.

502. BEHAVIORAL SCIENCE (2) Continued integration of biopsychosocial substrates with emphasis on adaptation, growth, and development, and behavioral correlates of disease and health.

503. HEALTH BEHAVIOR AND HUMAN ECOLOGY (3) Behavioral substrates with emphasis on health behavior, human ecology, stress, behavioral factors in disease, society, prevention, and health systems. Prerequisite: Beh.Sc. 502.

511. MEDICAL STATISTICS AND RESEARCH DESIGN (2) Use of theoretical and applied statistics in medical research design and in the interpretation of data.

531. BEHAVIORAL AND PHYSIOLOGICAL CORRELATES OF STRESS (3) Effects of stress on all physiological processes; role of learning, cognition, personality, and culture in adapting to stress.

533. BIOFEEDBACK AND THE CONTROL OF INTERNAL RESPONSES (2) Discusses theoretical and clinical applications of voluntary control over EEG, cardiovascular and muscle activity, body temperature, and other physiological processes.

535. NERVOUS SYSTEMS AND BEHAVIOR (3) Synthesis of behavior science, neurobiology, and physiology with emphasis on integrative functions of peripheral, central, and autonomic nervous systems.

537. MECHANISMS OF MEMORY (2) Discussion of physiological mechanisms involved in information storage and retrieval. Experimental design in memory research is emphasized.

551. HEALTH, ILLNESS, AND CULTURE (3) A medical sociology seminar devoted to the socio-cultural aspects of health and sickness.

555. BEHAVIOR CHANGE (3) Review of behavioral science research and theory relevant for behavior change procedures used in medicine.

- 590. COLLOQUIUM (1-3)

- 596. INDIVIDUAL STUDIES (1-9)

- 597. SPECIAL TOPICS (1-9)

### **BLACK STUDIES**

Students who wish to take courses in black studies may select from the following: Bl.St. 400, 401; C.Lit. 422, 423; Econ. 461; Ed.Th.P. 404, 411; Fr. 458; Geog. 444; Hist. 479; Ph.Ed. 412; Pl.Sc. 453, 454; RCLEd. 402, 467; Soc.W. (Soc.) 407; Soc.W. 471.

### **CHINESE (CHNS)**

- 496. INDEPENDENT STUDIES (1-18)

- 497. SPECIAL TOPICS (1-9)



**\*CLASSICS (CLASS)**

- 410. CLASSICAL EPIC (3)
- 411. CLASSICAL DRAMA (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

500. INTRODUCTION TO CLASSICAL SCHOLARSHIP (1-6) Lectures on the methods and materials of classical scholarship. To be scheduled by graduate students in their first semester and as necessary thereafter.

504. TOPOGRAPHY OF ANCIENT ROME (3) Lectures and readings on physical development of the ancient city of Rome from earliest habitation to time of later empire.

- 597. SPECIAL TOPICS (1-9)

**COMMUNITY DEVELOPMENT (COM D)**

- 402. POLITICS, POLICY, AND COMMUNITY ACTION (3)
- 404. COMMUNITY DEVELOPMENT THROUGH PLANNED CHANGE (3)
- 405. COMMUNITY MENTAL HEALTH: AN ECOLOGICAL APPROACH TO HUMAN SERVICES (3)
- 417. POWER, CONFLICT, AND COMMUNITY DECISION MAKING (3)
- 419. COMPARATIVE COMMUNITY DEVELOPMENT (3)
- 421. AGING AND SOCIAL POLICY (3)
- 433. PLANNING OF COMMUNITY SERVICE PROGRAMS (3)
- 434. EVALUATION OF COMMUNITY PROGRAMS (3)
- 435. COST-EFFECTIVENESS ASSESSMENT OF COMMUNITY PROGRAMS (3)
- 436. STRATEGIC PLANNING FOR AGENCIES AND COMMUNITIES (3)
- 440. MANAGING COMMUNITY SERVICES AND PROGRAMS (3)
- 441. VOLUNTEER PROGRAM ADMINISTRATION (3)
- 443. COMMUNITY ECONOMIC DEVELOPMENT PLANNING (3)
- 444. CONSUMER ADVOCACY AND OMBUDSMANSHIP (3)
- 445. (Adm.J. 445) CRIMINAL JUSTICE AND THE COMMUNITY (3)
- 450. COMMUNITY SERVICES STUDIO (1-6)
- 451. COMPUTER APPLICATIONS IN COMMUNITY DEVELOPMENT (1)
- 490. INTERNSHIP PLANNING (1)
- 495A. COMMUNITY DEVELOPMENT INTERNSHIP (6)
- 495B. SEMINAR: INTERNSHIP IN COMMUNITY DEVELOPMENT (3)
- 495C. RESEARCH IN FIELD WORK (5)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

**COMPUTATIONAL FLUID DYNAMICS**

Students interested in computational fluid dynamics may select the following courses, which are described under the majors of Aerospace Engineering and Mechanical Engineering: Aersp. 423, Aersp. (M.E.) 526, 527, Aersp. 529, and M.E. 540.

**EARTH AND MINERAL SCIENCES (EM SC)**

- 420. (L.A. 420, S.T.S. 420) ENERGY AND MODERN SOCIETY (3)
- 596. INDIVIDUAL STUDIES (1-9)

**EAST ASIAN STUDIES (EA ST)**

- 401. EAST ASIAN STUDIES (3-6)

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\*The readings are in English; knowledge of Greek and Latin is not required.

### **ENGINEERING (ENGR)**

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

### **ENVIRONMENTAL RESOURCE MANAGEMENT (E R M)**

405. SENIOR SEMINAR (1)  
410. POLLUTION OF ENVIRONMENTAL SYSTEMS (3)  
411. LEGAL ASPECTS OF RESOURCE MANAGEMENT (3)  
412. RESOURCE SYSTEMS ANALYSIS (3)  
413. CASE STUDIES IN ECOSYSTEM MANAGEMENT (3)  
495. INTERNSHIP (1-13)  
496. INDEPENDENT STUDIES (1-18)  
497. SPECIAL TOPICS (1-9)

### **FOLKLORE (FOLK)**

400. THEORY AND TECHNIQUES OF FOLKLORE (3)  
496. INDEPENDENT STUDIES (1-18)  
497. SPECIAL TOPICS (1-9)

### **GERONTOLOGY**

In several programs, students may select gerontology or adult development and aging as an area of specialization — in the behavioral and social sciences, in the biological sciences, and in certain professional programs. No major or degree in gerontology is offered. Information may be obtained from the Gerontology Center, S-211 Henderson Human Development Building.

### **GREEK (GREEK)**

401. INTRODUCTORY READING IN GREEK LITERATURE (3)  
420. GREEK PROSE AUTHORS (3-6)  
421. GREEK DRAMA (3-6)  
496. INDEPENDENT STUDIES (1-18)  
497. SPECIAL TOPICS (1-9)
509. GREEK SEMINAR (3-9)
517. GREEK RESEARCH (1-6) Prosecution of an assigned problem under the guidance of a member of the department.

### **HEALTH PLANNING AND ADMINISTRATION (H P A)**

401. COMPARATIVE HEALTH SYSTEMS (3)  
410. PRINCIPLES OF PUBLIC HEALTH ADMINISTRATION (3)  
420. ENVIRONMENTAL HEALTH (3-6)  
430. PRINCIPLES OF HEALTH PLANNING (3)  
431. HEALTH PLANNING METHODS (3)  
432. HEALTH SYSTEMS MANAGEMENT (3)  
433. HEALTH SYSTEMS THEORY (3)  
440. EPIDEMIOLOGIC BASIS FOR PLANNING (3)  
442. LONG-TERM CARE ADMINISTRATION (3)  
445. (Econ. 445) HEALTH ECONOMICS (3)  
496. INDEPENDENT STUDIES (1-18)  
497. SPECIAL TOPICS (1-9)

### **HOTEL, RESTAURANT, AND INSTITUTIONAL MANAGEMENT (HR&IM)**

402. LAYOUT AND DESIGN OF HOSPITALITY OPERATIONS (3)  
410. ADVANCED QUANTITY FOOD PRODUCTION (4)  
412. HOSPITALITY OPERATIONS PLANNING (3)  
435. FINANCIAL MANAGEMENT IN HOSPITALITY OPERATIONS (3)



- 442. MARKETING OF HOSPITALITY SERVICES (3)
- 450. VENDING MANAGEMENT IN THE HOSPITALITY INDUSTRY (3)
- 461. PERSONNEL FUNCTIONS IN THE HOSPITALITY INDUSTRY (3)
- 462. ORGANIZATIONAL BEHAVIOR IN THE HOSPITALITY INDUSTRY (3)
- 475. CAREER DECISION MAKING IN THE HOSPITALITY INDUSTRY (2)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

### **HUMAN DEVELOPMENT (H DEV)**

- 401. PROFESSIONAL ISSUES IN HUMAN DEVELOPMENT (1-3)
- 494. SENIOR THESIS (1-10)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
- 499. FOREIGN STUDY — HUMAN DEVELOPMENT (1-6)

516. METHODS OF RESEARCH IN HUMAN DEVELOPMENT (1-6) Review of problems and techniques of research in human development.

517. MULTIVARIATE STUDY OF CHANGE AND HUMAN DEVELOPMENT (3) Models of development and change derived from empirical research utilizing multivariate research design and procedures. Prerequisites: at least three statistics courses, including correlation and regression analysis.

### **DOCTORAL MINOR/OPTION IN THE HUMANITIES**

Doctoral candidates may pursue an individualized program of study leading to a certificate minor or option (15-18 credits) in a broadly interdisciplinary area in the humanities. This program will normally provide teaching experience in an area of the humanities, and certification will be granted by the College of the Liberal Arts.

### **INTERDISCIPLINARY PROGRAM IN THE HUMANITIES**

Qualified students who wish to receive a Ph.D. degree in one of the graduate major programs in the College of the Liberal Arts or the College of Arts and Architecture, and yet would like to receive an interdisciplinary education, may enter the interdisciplinary program in the humanities after they have been properly enrolled in one of the major programs, provided their interdisciplinary interest lies within the realm of the humanities.

### **INDUSTRIAL ARTS EDUCATION (IA ED)**

- 460. PLANNING AND MANAGEMENT OF INSTRUCTIONAL RESOURCES (3)
- 461. CONSTRUCTION ACTIVITIES IN THE ELEMENTARY SCHOOL (3)
- 462. CONTEMPORARY PROBLEMS IN INDUSTRIAL ARTS (2)
- 464. CURRICULUM AND INSTRUCTION: INDUSTRIAL STUDIES (3)
- 495. PREPROFESSIONAL EXPERIENCE IN INDUSTRIAL STUDIES (1-3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

561. HISTORY AND PHILOSOPHY OF INDUSTRIAL ARTS (2-3) Historical developments and concurrent educational philosophies of industrial arts in American education.

562. CURRICULUM DEVELOPMENT IN INDUSTRIAL ARTS EDUCATION (2-3) Analysis of curriculum innovations in industrial arts and cognate fields; strategies for implementing curricular change; construction and assessment of curriculum materials. Prerequisite or concurrent: I.A.Ed. 561. Prerequisite: teaching experience.

563. SUPERVISION AND ADMINISTRATION OF INDUSTRIAL ARTS EDUCATION (2-3) How to organize, supervise, and administer functioning programs of industrial arts; duties of a supervisor and director of industrial arts. Prerequisite or concurrent: I.A.Ed. 562. Prerequisite: teaching experience.

564. EVALUATION IN INDUSTRIAL ARTS (2-3) Construction of informal manipulative and written tests; use of standardized mechanical aptitude tests; construction and use of performance rating scales. Prerequisite: C.I. 400 or C.&S. 401.

## OTHER COURSES AND OPTIONS CARRYING GRADUATE CREDIT

568. RESEARCH IN INDUSTRIAL ARTS (2-3) Research techniques in industrial arts education. Prerequisite or concurrent: C.I. 400.

569. SEMINAR IN INDUSTRIAL ARTS (1-9) Directed intensive study, investigation, or research in selected phases of the program; reports and constructive criticism. Prerequisites: 6 credits in professional courses in industrial arts and teaching experience.

### ITALIAN (IT)

- 415. DANTE (3)
- 422. ITALIAN HUMANISM AND THE RENAISSANCE (3)
- 440. (Fr. 440, Span. 440) TEACHING OF ROMANCE LANGUAGES (3)
- 450. NINETEENTH-CENTURY ITALIAN LITERATURE (3)
- 460. TWENTIETH-CENTURY ITALIAN LITERATURE (3)
- 490. DANTE IN TRANSLATION (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

588. SEMINAR IN ITALIAN LITERATURE (3-12) Common and individual research in special problems.

### JAPANESE (JAPNS)

- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

### LABOR STUDIES (L S)

- 400. COMPARATIVE INDUSTRIAL RELATIONS SYSTEMS (3)
- 404. COLLECTIVE BARGAINING TRENDS (3)
- 411. TRADE UNION ADMINISTRATION (3)
- 414. THEORIES OF THE LABOR MOVEMENT (3)
- 433. THE LAW OF LABOR-MANAGEMENT RELATIONS (3)
- 435. LABOR RELATIONS IN THE PUBLIC SECTOR (3)
- 437. IMPASSE RESOLUTION IN LABOR RELATIONS (3)
- 458. (Hist. 458) HISTORY OF AMERICAN ORGANIZED LABOR SINCE 1877 (3)
- 495. LABOR STUDIES INTERNSHIP (1-12)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

### LANDSCAPE ARCHITECTURE (LARCH)

- 425. INTERMEDIATE LANDSCAPE DESIGN (4)
- 427. INTERMEDIATE LANDSCAPE PLANNING (4)
- 435. LANDSCAPE CONSTRUCTION I (4)
- 437. LANDSCAPE CONSTRUCTION II (5)
- 444. LANDSCAPE ARCHITECTURE FIELD TRIP (1)
- 445. ADVANCED LANDSCAPE PLANNING (5)
- 447. ADVANCED LANDSCAPE DESIGN (5)
- 457. PROFESSIONAL PRACTICE (1)
- 458. ADVANCED LANDSCAPE COMMUNICATIONS (2)
- 471. PARK PLANNING THEORY AND CONCEPTS (2)
- 472. PLANNING AND PUBLIC POLICY (3)
- 474. SITE ENGINEERING FUNDAMENTALS (1)
- 475. PARK SYSTEMS PRACTICUM (1)
- 495. INTERNSHIP (1-13)



## OTHER COURSES AND OPTIONS CARRYING GRADUATE CREDIT

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

518. ADVANCED PROBLEMS IN LANDSCAPE DESIGN (2-12) Selected problems for original investigation in the design, construction, and maintenance of landscape architectural projects.

521. TECHNICAL LANDSCAPE ARCHITECTURAL PRACTICES (2-12) Specific technical and professional problems in landscape architectural planning and practice.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

### LATIN (LATIN)

401. INTRODUCTORY READING IN LATIN LITERATURE (3)

402. LATIN LITERATURE OF THE REPUBLIC (3-9)

403. LATIN LITERATURE OF THE AUGUSTAN AGE (3-9)

404. LATIN LITERATURE OF THE EMPIRE (3-9)

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

500. LATIN LITERATURE (3-9) Readings in the major forms of Latin literature; content varies; course may be repeated.

510. LATIN SEMINAR (3-6)

518. LATIN RESEARCH (1-6) Prosecution of an assigned problem under the guidance of a member of the department.

### LIBERAL ARTS (L A)

400. CHANGING LIFE STYLES (1)

420. (E.M.Sc. 420, S.T.S. 420) ENERGY AND MODERN SOCIETY (3)

460. UNDERGRADUATE INTERNSHIP (1-6)

461. ACADEMIC ADVISER TRAINING (1)

480. (S.T.S. 480) TECHNOLOGY AND VALUES (3)

481. (Sp.Com. 481) COMPUTER APPLICATIONS TO COMMUNICATION STUDIES (3)

482. QUANTITATIVE METHODS FOR HUMANISTS I (3)

483. QUANTITATIVE METHODS FOR HUMANISTS II (3)

484. (Engl. 484) COMPUTATIONAL AND QUANTITATIVE STYLISTICS (3)

495. UNDERGRADUATE FIELD EXPERIENCE OR PRACTICUM (1-18)

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

582. APPROACHES TO PROBLEM SOLVING FOR HUMANISTS (3) A consideration of systematic individual and group approaches to problem solving and evaluation techniques. Prerequisite: introductory statistics.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

### LIBRARY STUDIES (L ST)

460. INTRODUCTION TO LIBRARY RESOURCES IN THE BIOMEDICAL SCIENCES (1)

470. FEDERAL AND LEGAL INFORMATION RESOURCES (3)

480. BIBLIOGRAPHIC RESOURCES AND SYSTEMS (3)

490. (Hist. 490) ARCHIVAL MANAGEMENT (1-3)

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

## OTHER COURSES AND OPTIONS CARRYING GRADUATE CREDIT

### LITHUANIAN (LITH)

500. STRUCTURE OF LITHUANIAN (3) Analysis of the phonology, morphology, and syntax of Lithuanian; comparative linguistic study of Balto-Slavic and Indo-European. Prerequisite: one graduate course in linguistics.

### MATERIALS SCIENCE (MATSC)

401. MATERIALS SCIENCE FOR TEACHERS I (3)

403. MICROSCOPY OF MATERIALS (2)

404. PROCESS MEASUREMENT AND CONTROL (1-3)

406. INTRODUCTION TO BIOMEDICAL MATERIALS (3)

408. (Geosc. 408) X-RAY DIFFRACTION (3)

411. (Geosc. 411) INSTRUMENTAL TECHNIQUES APPLIED TO MATERIALS AND MINERAL SCIENCE PROBLEMS (1-8)

*Unit A. X-RAY DIFFRACTION*

*Unit B. TRANSMISSION ELECTRON MICROSCOPY*

*Unit C. SPECTROSCOPY*

*Unit D. ELECTRON MICROPROBE ANALYSIS*

*Unit E. SCANNING ELECTRON MICROSCOPY*

*Unit F. ABSORPTION SPECTROSCOPY*

*Unit G. ION BEAM TECHNIQUES*

*Unit I. ELECTRON SPECTROSCOPY FOR CHEMICAL ANALYSIS AND AUGER ELECTRON SPECTROSCOPY*

412. QUANTITATIVE MICROSTRUCTURAL AND PARTICULATE CHARACTERIZATION (1)

416. MATERIALS PREPARATION (2)

420. MATHEMATICAL MODELING FOR MATERIALS SCIENTISTS (3)

430. CRYSTALLOGRAPHY AND X-RAY DIFFRACTION (2)

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

501. THERMODYNAMICS OF MATERIALS (3) Application of thermodynamics to materials equilibria and processes, including solution theory, electrochemical processes, capillarity, and the effect of stresses. Prerequisite: Chem. 451.

503. (G.M. 503) KINETICS OF MATERIALS PROCESSES (3) Introduction to application of transition state theory and mass transfer to the kinetics of materials and mineral processes. Prerequisites: Chem. 451; Mat.Sc. 501 or G.M. 521.

512. (G.M. 512) PRINCIPLES OF CRYSTAL CHEMISTRY (3) Relation of structure to ionic size and nature; influence of pressure and temperature on structure; chemical-structural defects, crystalline solutions, phase-transitions.

514. CHARACTERIZATION OF MATERIALS (3) Classical and new (microprobe, scanning microscope, magnetic resonance, and Mossbauer) techniques for the characterization of composition, structure, defects, and surfaces.

524. (G.M. 524) VIBRATIONAL SPECTRA OF MATERIALS AND MINERALS (2) Infrared and Raman spectroscopy of solid materials, with applications to mineralogy, materials characterization, and glass research. Prerequisites: Phys. 412, 471.

531. TRANSMISSION ELECTRON MICROSCOPY (2) Discussion of electron image contrast theory as a tool for study of atomic substructures in the materials and mineral sciences. Prerequisite: Mat.Sc. (Geosc.) 411B.

532. (G.M. 532) CRYSTAL STRUCTURE ANALYSIS (2) Experimental techniques for, and the theory of crystal structure determination. Prerequisite: Geosc. (Mat.Sc.) 408.

534. DIFFRACTION BY CRYSTALS (2) Interaction of radiation with matter: coherent and incoherent scattering, extinction, fluorescence, polarization. Prerequisite: Mat.Sc. (Geosc.) 408.

535. (G.M. 535) GEOMETRICAL CRYSTALLOGRAPHY (3) Derivation of lattices, types, point groups, and space groups, and group theory applied to crystallography and spectroscopy.

538. ELECTRON BEAM ANALYSIS OF SOLIDS VIA X-RAY AND ELECTRON EMISSION (3) Theory of phenomena occurring in electron-bombarded solids and their applications to analysis of solids.



## OTHER COURSES AND OPTIONS CARRYING GRADUATE CREDIT

540. CRYSTAL ANISOTROPY (3) Symmetry aspects of crystals and physical properties. Matrix and tensor methods. Prerequisite: Phys. 412.

542. MAGNETIC METHODS IN MATERIALS SCIENCE (3) Static magnetic (susceptibility type) and spectroscopic methods (nuclear and electron magnetic resonance, Mossbauer spectroscopy) for materials characterization and structural analysis. Prerequisite: Phys. 413.

554. ELECTRONIC SPECTRA OF MATERIALS (3) Crystallographic and thermodynamic applications of crystal field theory. Electronic spectra of crystals and glasses. Luminescent spectra and phosphor characterization. Prerequisite: Phys. 471.

570. CATALYTIC MATERIALS (3) Preparation and characterization of solid catalytic materials. Relationships between their surface, defect, and electronic properties and catalytic activity. Prerequisite: Chem. 452.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

### MINERAL ENGINEERING (MIN E)

414. PLANNING AND CONTROL FOR THE MINERAL INDUSTRIES (3)

415. MANAGEMENT IN THE MINERAL INDUSTRIES FOR ENVIRONMENTAL, LEGAL, AND HEALTH AND SAFETY PROBLEMS (3)

416. DESIGN OF TRAINING PROGRAMS FOR THE MINERAL INDUSTRIES (3)

417. COMPUTER-AIDED ANALYSIS OF MINING SYSTEMS (3)

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

### PATHOLOGY (PATH)

501. PRINCIPLES OF PATHOLOGY (4) The fundamentals of reaction to injury at cellular and tissue levels emphasizing the pathogenesis of functional, structural, and biochemical abnormalities.

520. BIOLOGY OF NEOPLASIA (3) Detailed examination of the initiation and pathogenesis of animal neoplasms with emphasis on the relationship to human neoplasia. Prerequisite: admission to College of Medicine.

522. CANCER IMMUNOLOGY AND IMMUNOTHERAPY (2) Detailed study of recent advances in host response to malignancy in man and experimental animals. Prerequisite: Path. 501 or Micrb. 554.

597. SPECIAL TOPICS (1-9)

### PEDIATRICS (PED)

525. CLINICAL GENETICS (5-10) Mendelian and molecular principles of human genetics; genetic bases of human disease, quantitative human genetics, prenatal diagnosis, genetic counseling.

526. HUMAN CYTOGENETICS (2) Human chromosome identification; structure, replication, and evolution of human and other eukaryotic chromosomes in cytogenetic and molecular terms.

### PLANT SCIENCE (PLTSC)

400. PRINCIPLES OF PLANT SCIENCE RESEARCH (2)

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

### POPULATION ISSUES

Qualified students may select population issues studies as an option of specialization when majoring in economics, geography, sociology, anthropology, rural sociology, or agricultural economics. Additional information is given under the description of those majors in the preceding section.

### **PORTUGUESE (PORT)**

- 405. ADVANCED COMPOSITION AND CONVERSATION (3)
- 456. BRAZILIAN LITERATURE IN ENGLISH TRANSLATION (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

588. SEMINAR IN PORTUGUESE AND BRAZILIAN LITERATURE (3-12) Common and individual research in special problems.

### **PROFESSIONAL SKILLS MINOR/OPTION**

This minor/option seeks to broaden the analytic, informational, and communications skills that are required of all Ph.D. programs. Doctoral candidates in any disciplinary major at the University may enroll. The program requires the completion of the following course work.

Total credits required: 15.

- L.A. 582. APPROACHES TO PROBLEM SOLVING FOR HUMANISTS (3)
- L.A. 596. INDIVIDUAL STUDIES (3)
- L.St. 480. BIBLIOGRAPHIC RESOURCES AND SYSTEMS (3)
- ENGL. 418. ADVANCED TECHNICAL WRITING AND EDITING (3)
- or ENGL. 417. THE EDITORIAL PROCESS (3)
- SP.COM. 552. ORAL COMMUNICATION IN INDUSTRY, BUSINESS, AND GOVERNMENT (3)

### **RELIGIOUS STUDIES (RL ST)**

- 400. THEORIES OF RELIGION (3)
- 401. SEMINAR IN COMPARATIVE RELIGION (3)
- 402. CONTEMPORARY RELIGIOUS THOUGHT (3)
- 408. HINDU STUDIES (3)
- 409. BUDDHIST STUDIES (3)
- 411. JEWISH STUDIES (3)
- 420. MAJOR CHRISTIAN THINKERS (3)
- 422. RELIGION AND AMERICAN CULTURE (3 per semester, maximum of 6)
- 430. RELIGIOUS ETHICS (3)
- 479. (Psy. 479) RELIGION AND CULTURE IN FREUDIAN THOUGHT (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
- 502. STUDIES IN COMPARATIVE RELIGIONS (3-6) Cross-cultural comparative studies of two or more world religions.
- 505. SEMINAR IN ASIAN RELIGIONS (3-6) Studies in selected Asian religions.
- 521. ISSUES IN WESTERN RELIGION (3-6) Seminar. Study of selected issues in Western religion.
- 522. ADVANCED STUDIES IN AMERICAN RELIGION (3-6) In-depth inquiry into either a period; a movement, or a topic of American religion.
- 530. RELIGION AND SOCIETY (3-6) Studies of mutual influences and effects of religion and secular phenomena.
- 532. RELIGION AND SOCIAL PROBLEMS (3-6) Study of a selected social issue, or constellation of issues, with analysis of its religious and normative dimensions.
- 536. RELIGIOUS STRUCTURES AND PROCESSES (3-6) Study of the relationship between religion as social structure and as a dynamic social function.
- 539. ADVANCED STUDIES IN RELIGIOUS ETHICS (3-6) A systematic study of the structure and essential themes of ethics of religious institutions and thinkers.
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)



## RUSSIAN (RUS)

- 426. DOSTOEVSKY'S MAJOR FICTION IN ENGLISH (3)
- 427. TOLSTOY IN ENGLISH TRANSLATION (3)
- 430. METHODS AND MATERIALS FOR TEACHING RUSSIAN (3)
- 450. HISTORY OF THE RUSSIAN LANGUAGE (3)
- 460. LINGUISTIC ANALYSIS OF CONTEMPORARY RUSSIAN (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

\*1G. TECHNICAL RUSSIAN FOR GRADUATE STUDENTS (3) Prepares student to translate technical and scientific texts. No previous knowledge of Russian is required.

\*2G. RUSSIAN TEXTS (3) Development of skill in translating Russian texts in the sciences and social sciences. Prerequisite: Rus. 5 or 1G.

- 501. READINGS IN RUSSIAN LITERATURE (3-6) Prerequisite: Rus. 204.
- 525. PUSHKIN (3) Pushkin's significance in Russian literature; his relation to other European literatures; *Eugene Onegin* and selected shorter works.
- 540. EIGHTEENTH-CENTURY RUSSIAN LITERATURE (3) Study of the major writers and literary developments in this period of the secularization and modernization of Russian literature.
- 542. SEMINAR IN SOVIET LITERATURE (3-6) Works of representative Soviet writers; individual research in contemporary Soviet literature and literary criticism.
- 570. OLD RUSSIAN LITERATURE (3) Analysis of Russian literary monuments in the original, 1100-1700. Prerequisite: Slav. 550.
- 602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

## SCIENCE (SC)

- 400. CONSEQUENCES OF SCIENCE (1)

## SCIENCE, TECHNOLOGY, AND SOCIETY (S T S)

- 420. (E.M.Sc. 420, L.A. 420) ENERGY AND MODERN SOCIETY (3)
- 430. FOOD AND MAN: TECHNOLOGY AND FEEDING THE WORLD POPULATION (3)
- 432. (Phil. 432) MEDICAL ETHICS (3)
- 435. (Phil. 435) THE INTERRELATION OF SCIENCE, PHILOSOPHY, AND RELIGION (3)
- 460. SCIENCE AND PUBLIC POLICY (3)
- 470. TECHNOLOGY ASSESSMENT AND INDICATORS OF THE QUALITY OF LIFE (3)
- 471. RADIATION, REACTORS, AND SOCIETY (3)
- 480. (L.A. 480) TECHNOLOGY AND VALUES (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

NOTE: This program is designed to examine critically the impact of scientific investigation and technological development on society and the influence of human needs on scientific investigation and technological development.

## SLAVIC (SLAV)

- 500. BIBLIOGRAPHY AND RESEARCH TECHNIQUES (3) Tools and methods of research, designed for students preparing to do independent investigation of problems in Slavic languages and literatures.
- 510. STRUCTURE OF THE SOUTH SLAVIC AND WEST SLAVIC LANGUAGES (3-12; 3 credits per language) Linguistic analysis of a particular South Slavic (Bulgarian, Macedonian, Serbo-Croatian, Slovenian) or West Slavic (Czech, Lusatian, Polish, Slovak) language. Prerequisite: Rus. 460 or one graduate course in linguistics.
- 550. OLD CHURCH SLAVIC (3) Reading and study of that corpus of religious and liturgical documents representing the first written records of a Slavic tongue.

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\*No graduate credit is given for this course.

**SOCIAL WORK (SOC W)**

- 401. SOCIAL WORK METHODS: INDIVIDUALS, FAMILIES, AND SMALL GROUPS (4)
- 409. (SOC. 409) RACIAL AND ETHNIC INEQUALITY IN AMERICA (3)
- 411. SOCIAL WORK METHODS: ORGANIZATIONS AND COMMUNITIES (4)
- 415. PREPLACEMENT SEMINAR (1)
- 442. SOCIAL WORK PRACTICE ANALYSIS (3)
- 450. PUBLIC WELFARE POLICY AND SERVICES (3)
- 460. INTEGRATED SOCIAL WORK METHODS SEMINAR (3)
- 471. RURAL SOCIAL WORK (3)
- 495. FIELD WORK IN SOCIAL WELFARE (4-12)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

**OTHER MEMBERS OF THE GRADUATE FACULTY**

**Senior Members of the Graduate Faculty**

Sigmund S. Birkenmayer, Ph.D. (Wisconsin) *Professor of Slavic Languages*  
Walter F. Donlan, Ph.D. (Northwestern) *Associate Professor of Classics*  
Paul M. Harrison, Ph.D. (Yale) *Professor of Religious Studies*  
Thomas F. Magner, Ph.D. (Yale) *Professor of Slavic Languages*  
Joseph Paternost, Ph.D. (Indiana) *Professor of Slavic Languages*  
Charles S. Prebish, Ph.D. (Wisconsin) *Associate Professor of Religious Studies*  
William R. Schmalstieg, Ph.D. (Pennsylvania) *Professor of Slavic Languages*

**Associate Members of the Graduate Faculty**

Gary T. Alexander, Ph.D. (Chicago) *Assistant Professor of Religious Studies*  
Archibald Allen, Ph.D. (Queen's Belfast) *Associate Professor of Classics*  
James J. Gebhard, Ph.D. (Indiana) *Assistant Professor of Russian*  
Ernest B. Lowrie, Ph.D. (Yale) *Associate Professor of Religious Studies and American Studies*  
Bruce M. Stephens, Ph.D. (Drew) *Associate Professor of Humanities and Religious Studies*  
Judith Van Herik, Ph.D. (Chicago) *Assistant Professor of Religious Studies*  
E. A. Vastyan, B.D. (Episcopal Theological, Cambridge) *Professor of Humanities and Religious Studies*



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